

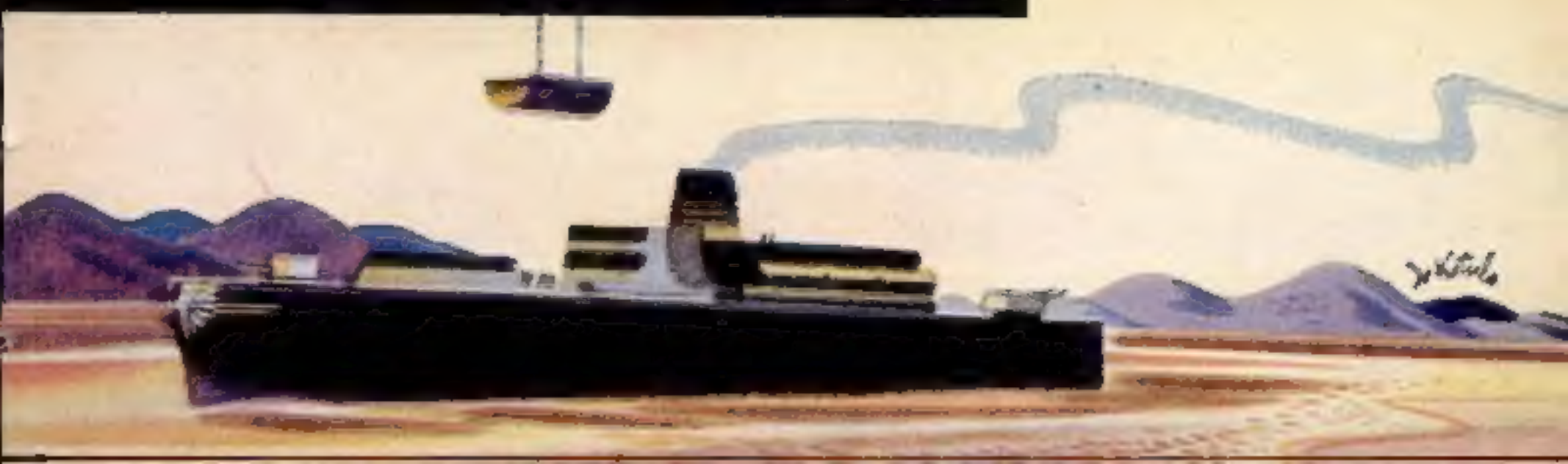
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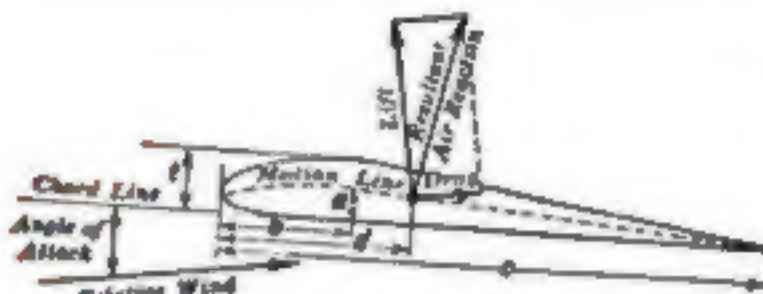
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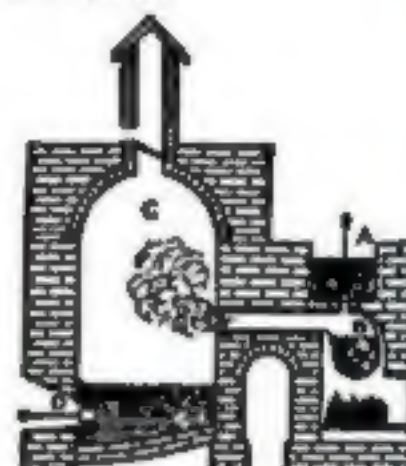
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Elements of an airfoil



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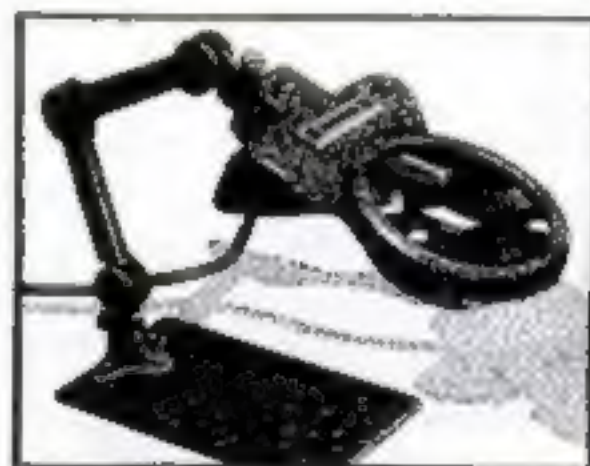
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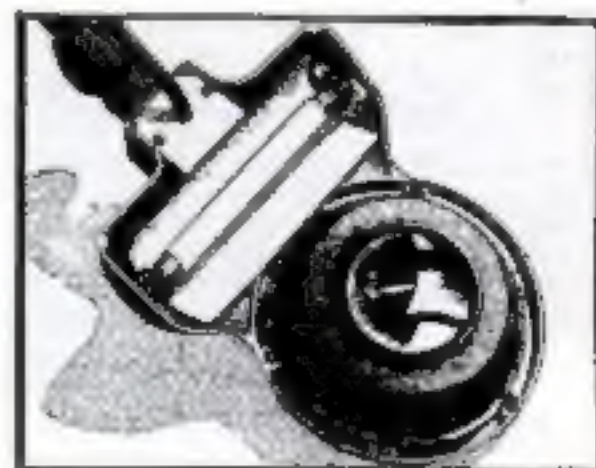
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Z-65



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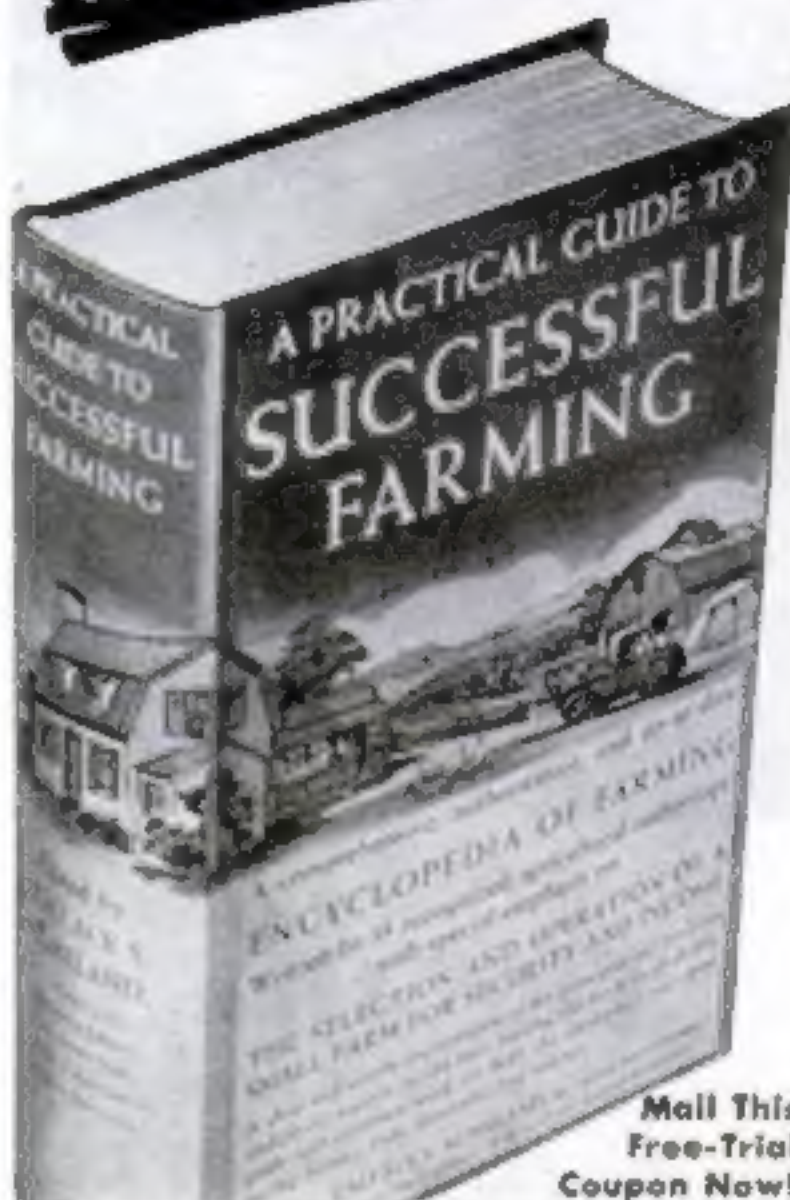
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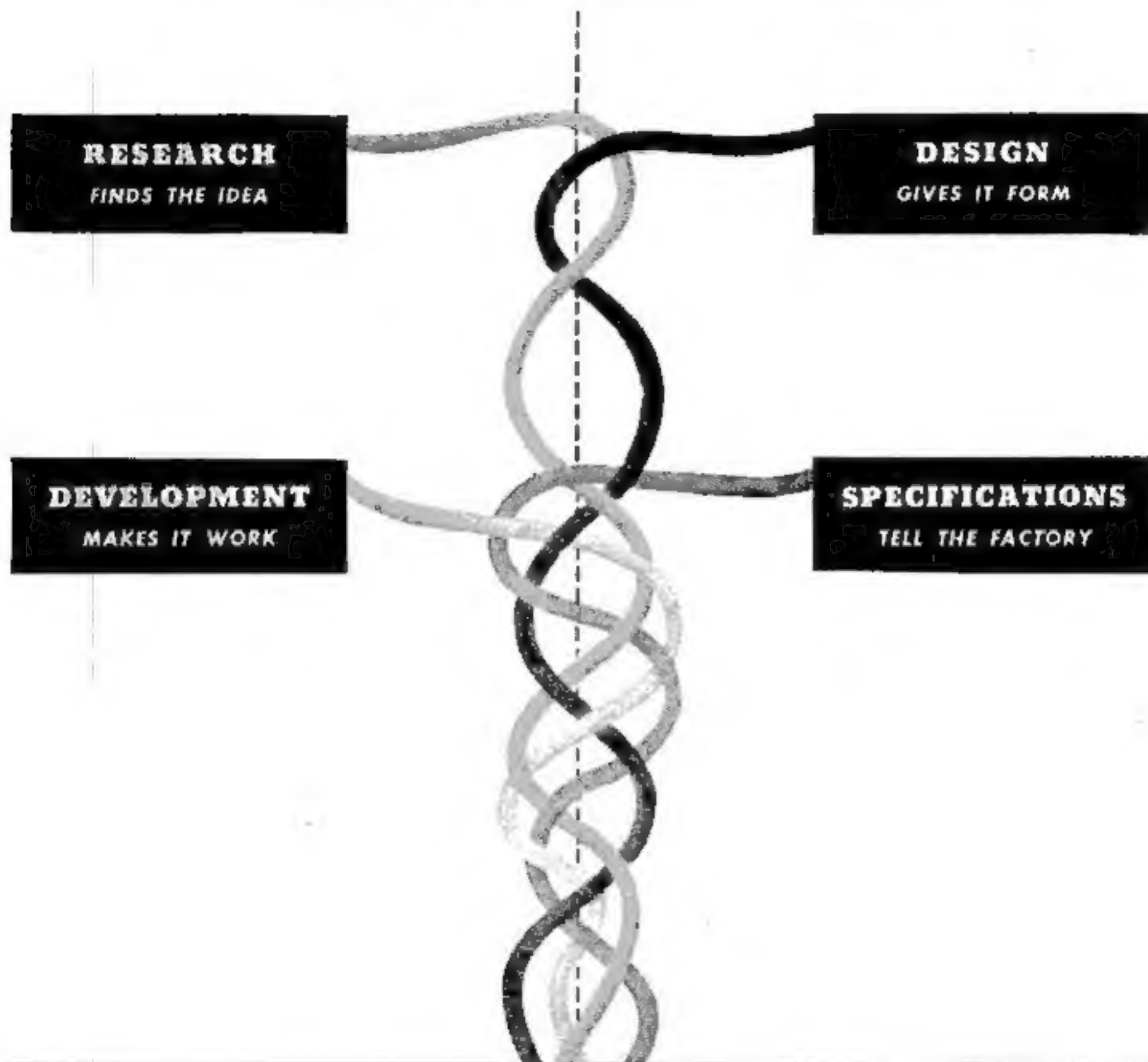
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G. EDWARD PENDRAY, Westinghouse executive, probably knows as much about rockets and jet propulsion as anyone else in the U.S. As a director and past president of the American Rocket Society, he has had a part in the research in this field. In an article on page 70 he dispels many mistaken ideas about reaction power and paints the endless possibilities opened up by harnessing Newton's Third Law of Motion.

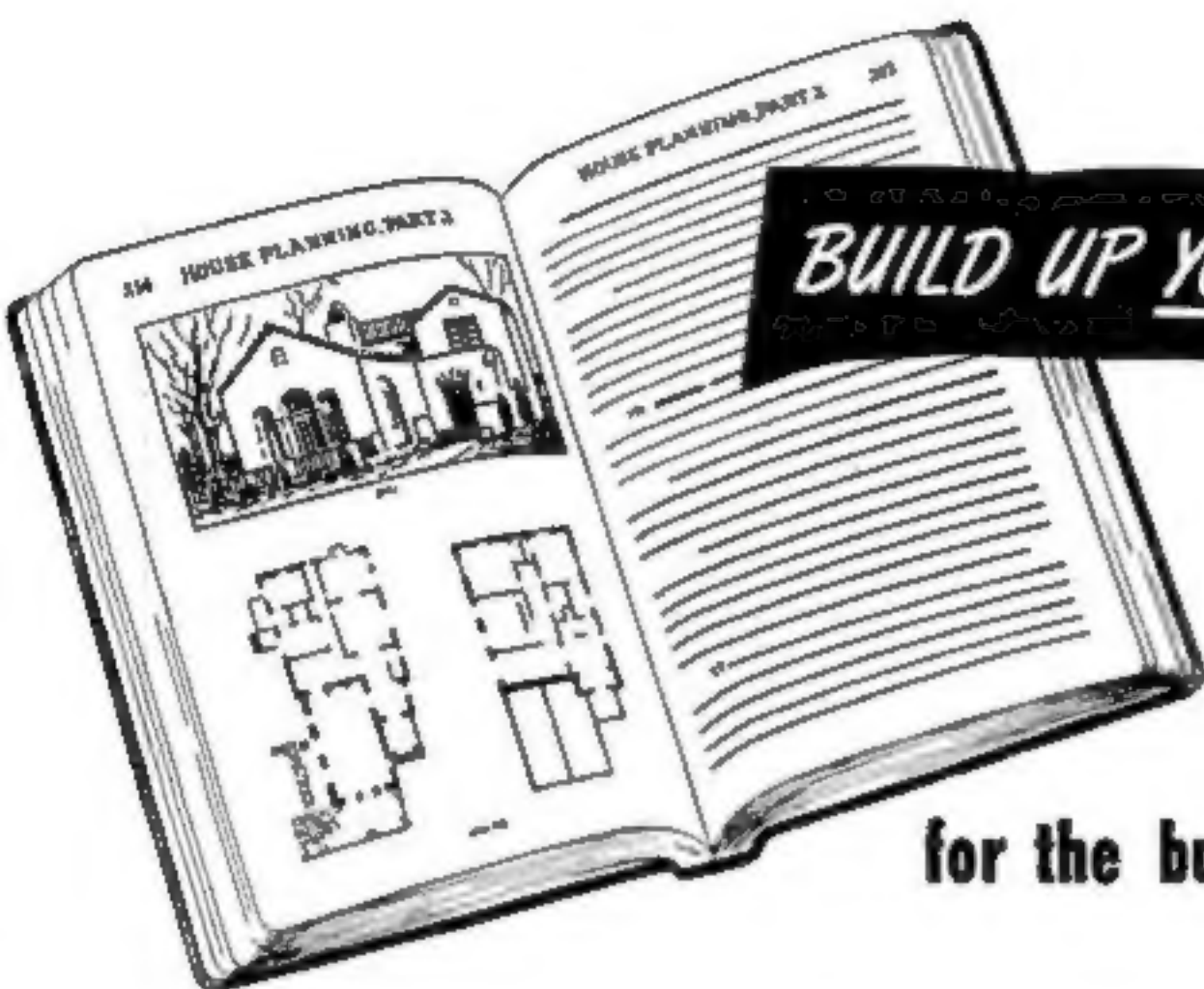
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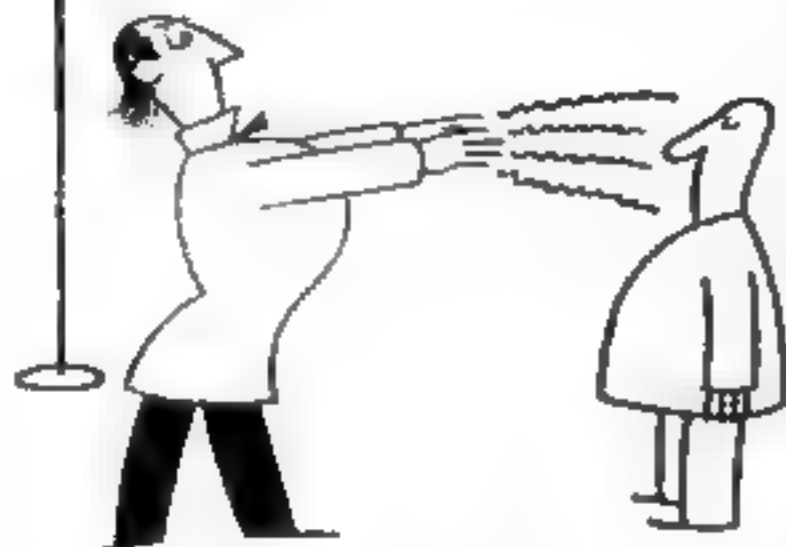
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THE VENTURA has turned out to be one of the Navy's handiest planes. This land-based patrol plane annoys the Japs with bombs, depth charges, torpedoes, and plain machine-gun bullets. You'll like our pages of full-color photos showing this versatile slugger at its work of punching holes in the East Asia Co-Prosperity Sphere.

TELEVISION has its technical tricks, just as the movies have. Laboring under the handicap of instantaneous production, video technicians have worked out their own methods of creating such effects as lap dissolves, animated maps, puppets in scenes with living people, ghosts, snow, rain, blizzards, montages, and what have you. Gilbert Sonbergh lets you in on some of the secrets of the studios.

PARACHUTES are not new. Leonardo da Vinci predicted their use, and early balloonists used them. But it's a far cry from the stunt man's parachute to the practically infallible canopies under which modern paratroopers and aviators float safely to earth. Volta Torrey tells the exciting story of the development of the parachute and describes its use as a weapon of modern war.

GERMANY'S JET PLANES. We have heard a lot about American and British jet planes—but what about the Germans' efforts in this new field? Our flyers encountered the first Nazi jet job in July 1944, and two other models appeared later. How good were they? An article describes these planes, tells how they compare with our own Airacomet and Shooting Star, and assays their military value.

NEW WOODS for the craftsman are coming from research carried out at the U. S. Department of Agriculture's Forest Products Laboratory. Under such weird names as impreg, compreg, staypak, and uralloy, they offer a selection of craft materials combining qualities not found together in natural woods. You will want to know them—what they are like and what you can do with them.

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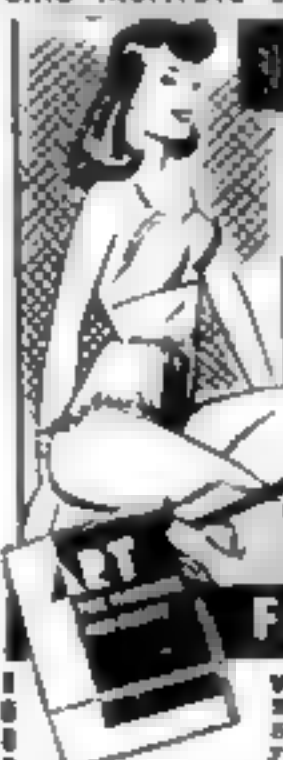
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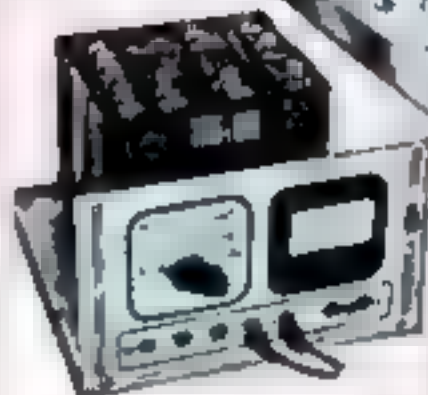


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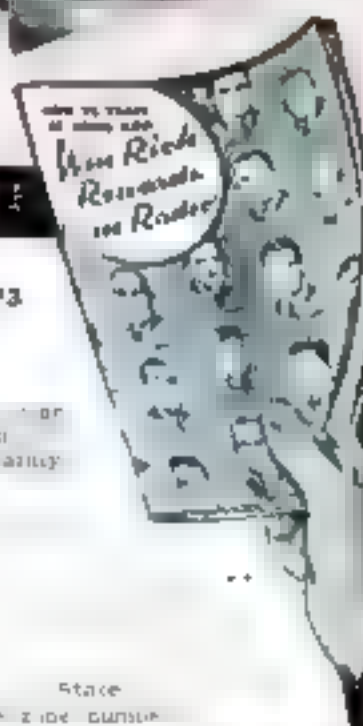
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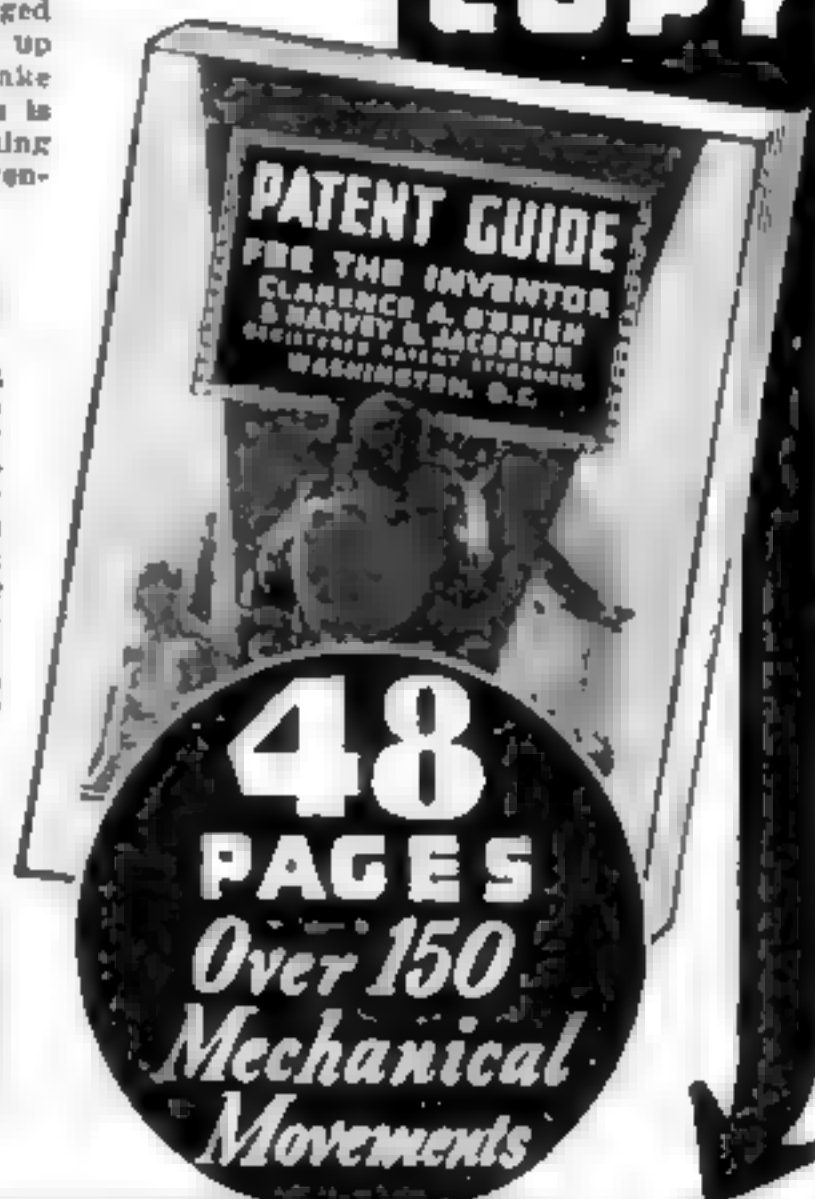
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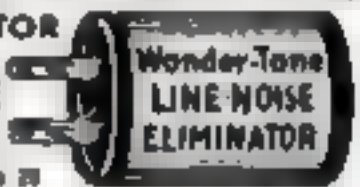
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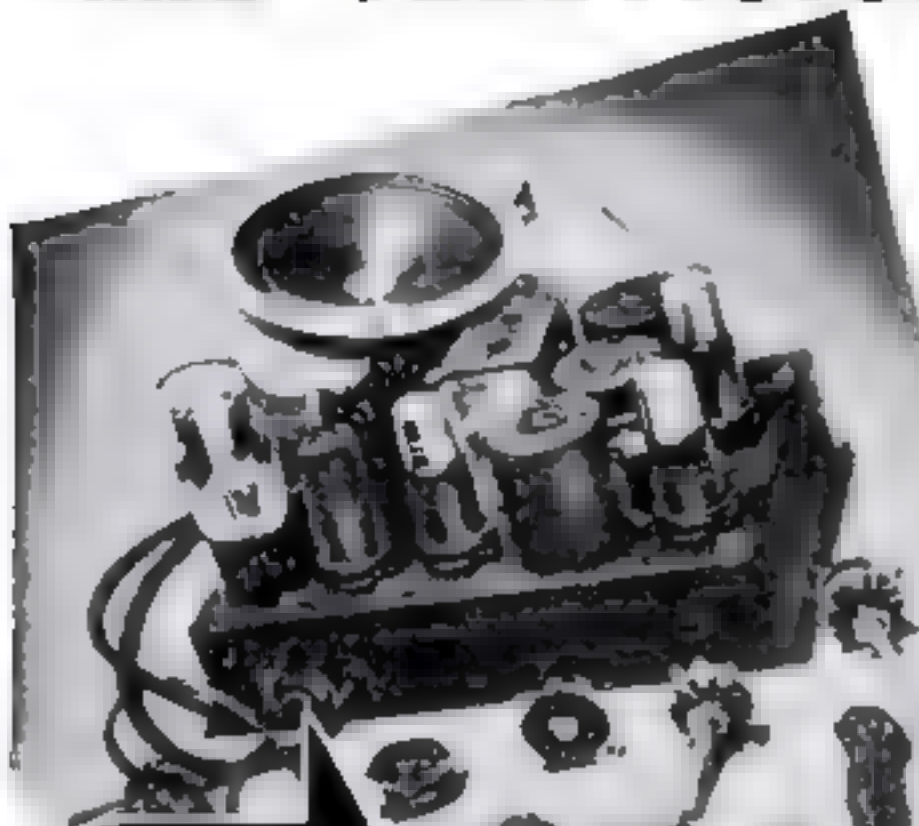
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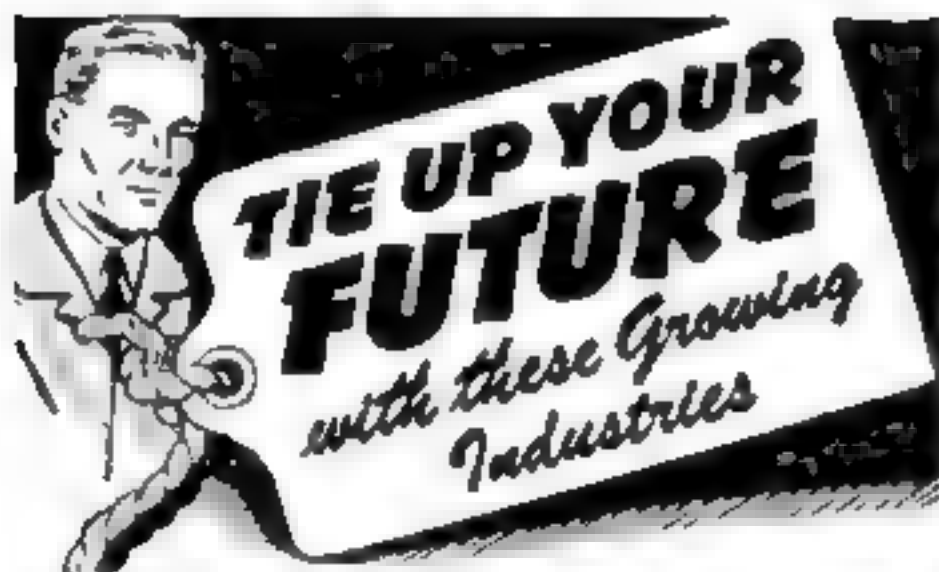
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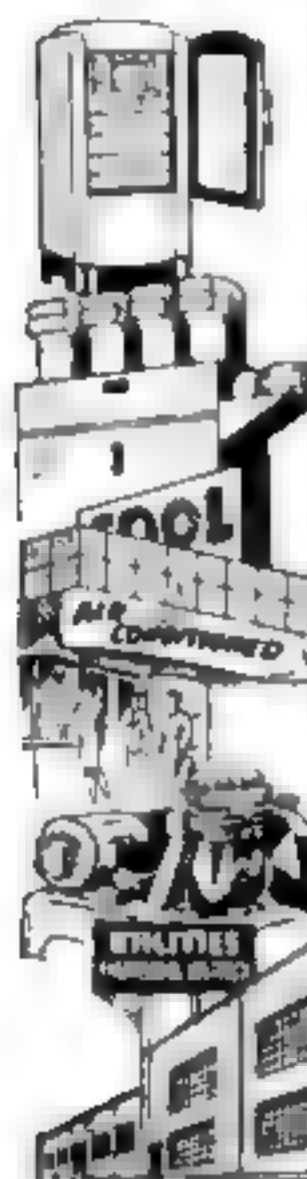
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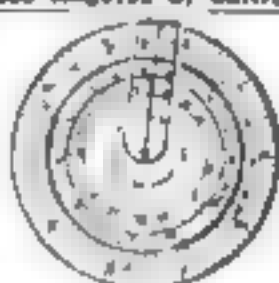
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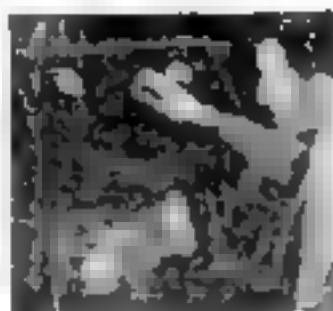
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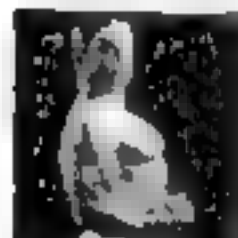
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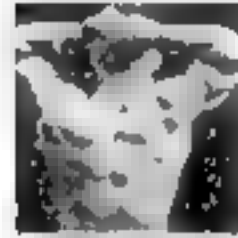


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Thomas E. Dewey, Governor of New York State, examines an enlarged page of Popular Science Monthly at General Electric's big plant in Schenectady.

New York's Governor Gets Low-Down on B-29 Guns

WHEN Gov. Thomas E. Dewey, of New York, visited us at the General Electric Co., Schenectady, N. Y., he showed particular interest in a reproduction of a page from POPULAR SCIENCE MONTHLY for February. Big blowups of these drawings are hung in many parts of the aero division.—T. C., Schenectady, N. Y.

Governor Dewey was only one of a lot of good people who were stopped by these drawings. They were made by Stewart Rouse, POPULAR SCIENCE staff artist.—Ed.

He Charted His Course With the Aid of P.S.M.

EACH year since grade-school days, I have given my son P. S. M. as a Christmas gift, and he has kept every copy for reference. From its wealth of valuable material, he has gathered knowledge that has helped him in intelligence tests. He will graduate from high school in June, and plans to enter college immediately, with his mind already made up to become a chemical engineer. Your magazine has been a determining factor in his desire to pursue a scientific course.—Mrs. R. H. B., Westmont, N. J.

Most of the Other People Who Answered Were Right, Too

HERE is my solution to R. E.'s problem about the deer in the February issue. The ratio of the distances between the two hunters and the fulcrum of the fence rail is inversely proportional to the respective weights of the hunters. These weights are in the ratio of 2 3; therefore the distances are in the ratio of 3 2. This gives a proportion for the balance of $180 \text{ 3} :: 120 \text{ 2}$.

Since the weight of the deer is unknown, let us call it x . Now reverse the order of the weights in the proportion and add x to the 120 pounds. Then you have $180 \text{ 2} :: (120+x) \text{ 3}$. Since, in a proportion, the product of the means is equal to the product of the extremes, we get the equation, $240+2x=540$, from which it is a simple matter to find the value of x , the weight of the deer—150 pounds.—D. D. Newark, N. J.

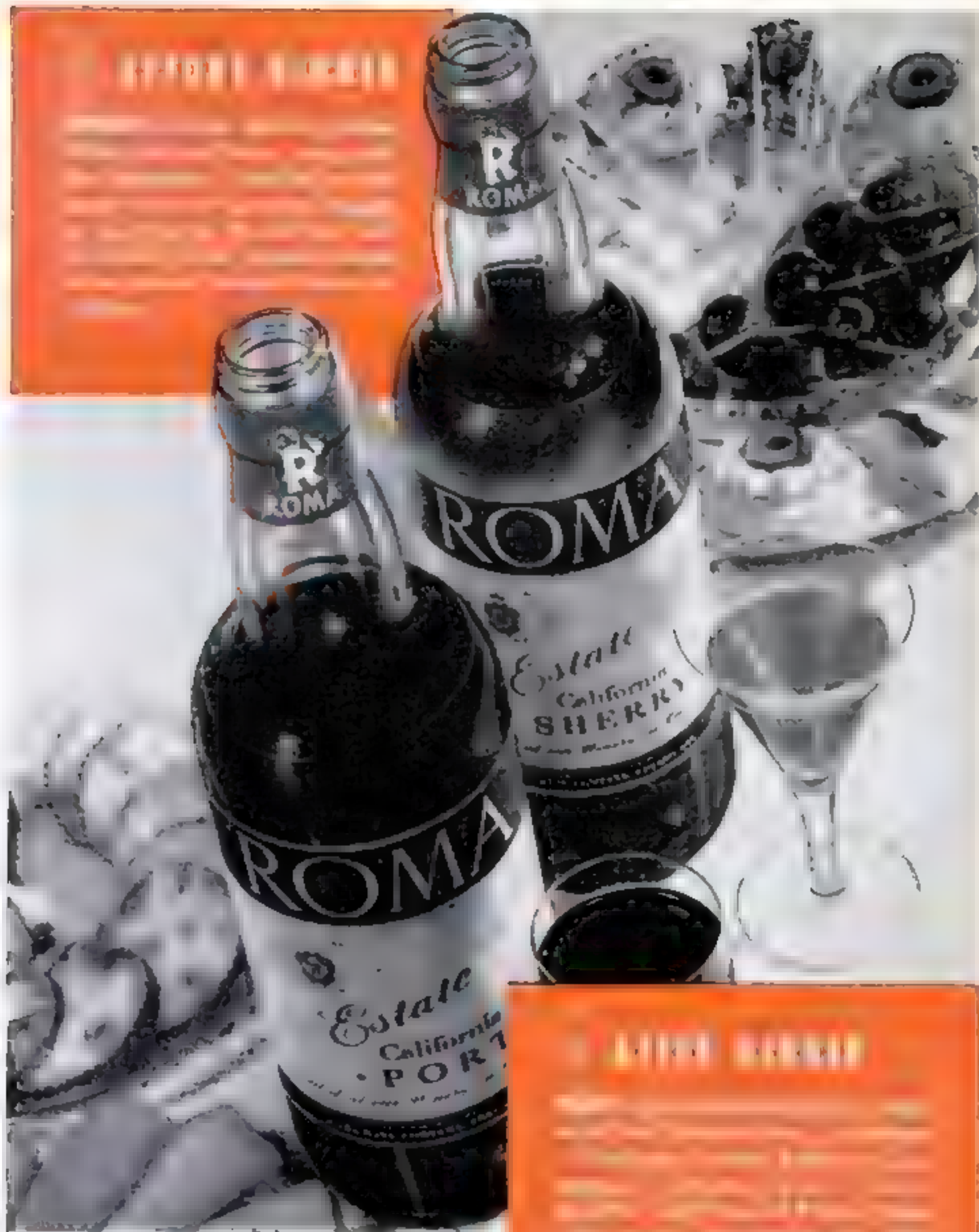
Constructive Thoughts on Joining Up Sewer Pipes

PLUMBERS connect cast-iron sewer pipes by inserting the small end of one length into the bell end of the next length, then packing with oakum and pouring in molten lead. The lead doesn't stick to the cast iron, but merely serves to fill the space it occupies. On cooling, the lead shrinks away from the pipe. So the plumber calks the lead tightly in place with a hammer and a special tool. He then gives the line a water test to show up the leaky joints. It's obviously a poor system of connecting pipes.

Some one should devise a way to tin the inside of the bell end of the pipe and also the outside part of the small end that fits into it. Then when lead is poured into the joint, it would "marry" the two tinned cast-iron surfaces. The lead would actually stick to them, and so produce a truly rigid and watertight connection without hammering in of the lead. Tinning should be done at the factory, but the process could be carried out by the plumber right on the job. A soldering flux may or may not be necessary. Step right up, young man; a fortune's impatiently waiting for you.—Pfc. A. V., New York City.

Sounds good, A. V., but offhand we wonder whether shrinkage won't put the bond between the lead and the tinned surface under tension and eventually result in failure. Also, for a sound bond, the tinned surfaces should be heated to the temperature of the lead by means of a blowtorch. Merely pouring in the lead won't supply enough heat, we're afraid, for a perfect bonding of the metals.—Ed.





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Readers Say:

Sane Thoughts from a Reader Who's "Crazy About Planes"

THE POPULAR SCIENCE article, "These Are the Planes You Will Fly After the War," interested me very much, but I have a few ideas of my own on the subject. The analysis proved one thing: entries by professionals cast aside such things as built-in beds or icebox units. They do not care to fly portable hotels. At the same time, the nonprofessional entries put down whatever feature appealed to the eye. You weren't fooling when you said that the plane of tomorrow will be built for comfort. Of course there were many exceptions, but, generally speaking, little thought was given to the performance or practicability of the plane.

I'm sure three quarters of the people who entered the contest could not afford the plane they voted for. I should think nonprofessionals would aim for simplicity and efficiency. In my opinion, the best all-round type of plane is the seaplane, considered a low type of ship by many pilots. May the prospective speed demons be reminded of the Supermarine seaplane, prototype of the Spitfire that took several speed records over the world.

Every private flyer is conscious of the maze of rules and regulations that foreshadow each flight. With such things as private jet propulsion, roadable helicopters, and planes turning into boats, a man'll have to spend three years learning the rules.—J. N. M., West Englewood, N. J.

Can Anyone Discover What This Man Wants To Say?

KNOWING full well that I could do no better, I still object strenuously to a scientific magazine like P. S. M. describing the expanding lattice effect, otherwise the pantograph idea,

as the "lazy-tongs principle." Lazy tongs are a contraption with which tramp comedians in old vaudeville days used to pick up cigar butts. The name isn't descriptive. Can't some clever POPULAR SCIENCE reader suggest a short, understandable, scientific word for this lazy term?—F. J., Philadelphia, Pa.



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Readers Say:

You Might Also Use Them for Making Clam Chowder

IN THE Readers Say department you have told us how to use old flashlight batteries and shirt cardboards, but now I would like to ask what to do with old bicycle tires. I am a paper carrier, and I wear out about four tires a year. After a while that makes quite a bunch. I'd like to know what to do with them.—P. M. J., Charlottesville, Va.



No doubt other readers will have many suggestions. We'll start off with doorstops and cushions on which to unload heavy articles from trucks.—Ed.

With One Arm Missing, He Does Practically Everything

AFTER reading the letter of P. C., Montreal, Canada, in the February issue, I have something to say to the boys who have lost an arm in this war. I lost my right arm in a hunting accident in 1928, and I believe I can do more things with my one hand than the average man does with two. I have been tying my shoelaces for years, and I can lace them as tight and tie them as well as a person with two hands; all it takes is a little practice. I still go hunting, and can shoot well with a light gun. I bowl, play golf, play baseball, and dance. I learned to swim with less than five hours of instruction.

I learned to take shorthand at the rate of about 130 words a minute. I devised a touch system on a typewriter for my left hand and reached a speed of 61 words. I have an almost complete woodworking shop, where I built my own workbenches, mounted my power tools, and attached electric motors to them with convenient switches.

I have also done mechanical work, and I used to overhaul my own car. I just finished rebuilding a $\frac{1}{2}$ -hp. motor for a scooter. At one time I serviced radios and built one for myself. I drive my car everywhere, even through Chicago's Loop. I dress myself every morning, tie my shoes and necktie, and button my left sleeve. So don't cut off your shoelaces, fellows; tie them like other people do.—C. J. R., Freeport, Ill.

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SO IT NEEDS FIXING

By S. T. CHRISTENSEN
the "Fix-it Man"

WELL, I guess I'm the fellow to see, for I've repaired thousands of refrigerators (home and commercial both), vacuum cleaners, radios, washing machines, irons, fans, lamps, mangles, motors, etc. In fact, many of my customers call me their "electrical appliance doctor." And, "doctoring," I might add has paid me a good substantial income for quite a few years. Funny, in a way, how I got started. Always liked to tinker and by experimenting around I found that most electrical appliances had many things in common. That, regardless of what the appliance was used for, or who the manufacturer was, the basic principles were much the same. From fixing my own appliances to fixing friends' and then for strangers at a fee, seems now to have been but a small step.

What to Charge?

At first, I let the owner decide the charge and, frankly, I was amazed at what I earned per hour. But then, when one figures what initial costs are involved in buying most electrical appliances, one can readily see that spending extra dollars for repairs is well worth while. Before long I was making more in my spare time repairing than from my regular job. The result . . . I went into business for myself. When war came, business boomed, for new appliances were not available.

For a while, repair parts (needed on some jobs) were a little difficult to get. But that

situation seems to have adjusted itself for many repair parts have today the high priority rating of AA2. After all, we must provide for the health and well-being of our civilian population.

The Future Offers

Friends ask me about my future. And, I think I've got a grand one. Age is no handicap in repairing. I have in my files enthusiastic letters from repairmen ranging in age from 18 to 79 years. After the war, we're bound to see hundreds of new products on the market . . . products that the average person never dreamt of. These new products and our old appliances are all going to need at some time or other "fixing." Well, I'll still be the fellow to do it. The field open for appliance repairmen is unlimited. I don't worry at all about too much competition.

If You Are Ambitious

To the contrary, I've prepared a complete course, chuck full of simple, easy to understand photos and drawings and written in the same non-technical language as this article. I know the course is good, because I have hundreds of men all over the country writing to me telling me how the course has helped swell their pockets with cash. If you too want to prepare now for your future, I suggest you read the next page and send me the handy coupon."

Adv.



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I am a mechanic for the Western Union Telegraph Co. Three days after receiving the lessons in Refrigeration I earned the exact cost of the course.—Henry S. Lee, Washington, D. C.
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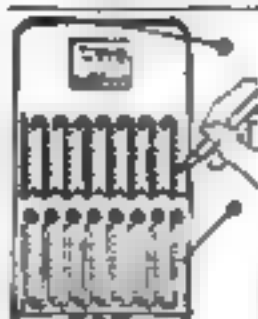
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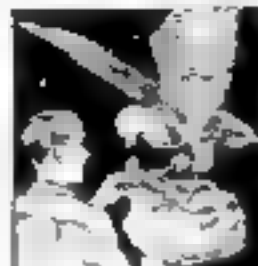
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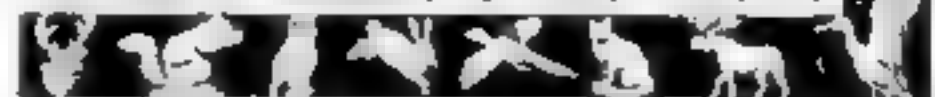


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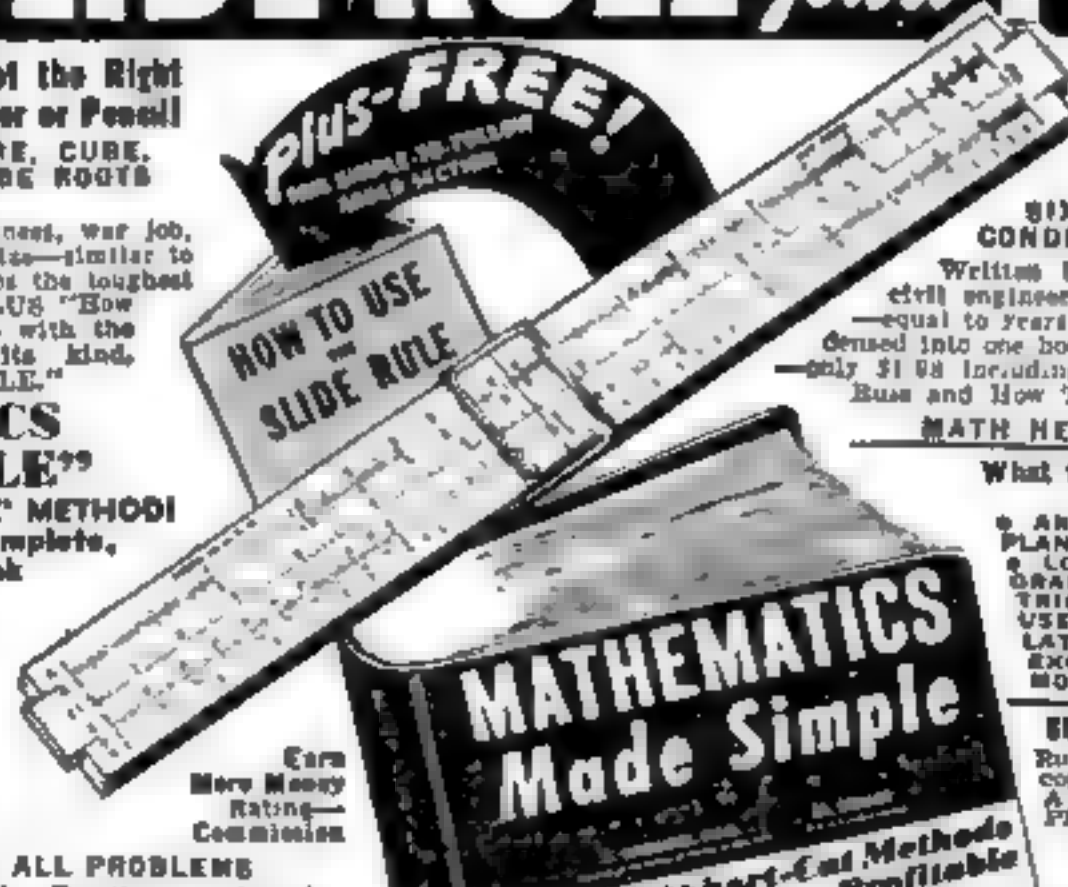
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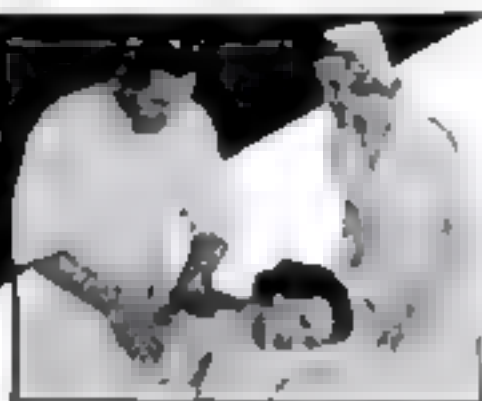
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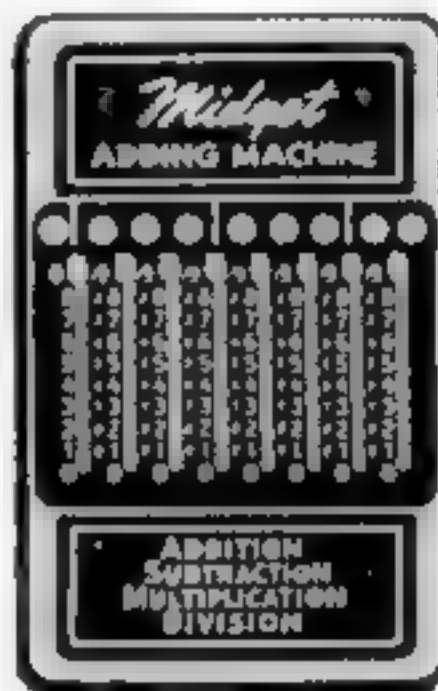
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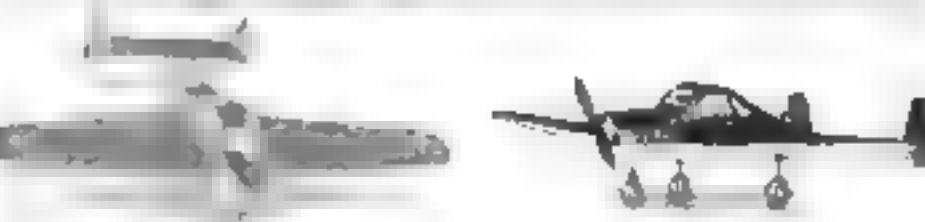
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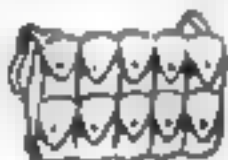
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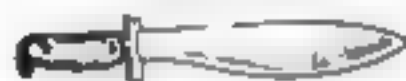
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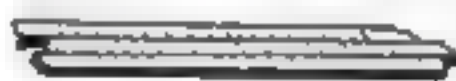
Army Bandoleer and heavy bandolier. Slightly used but serviceable. **K128-3 POCKET EA. 29c**
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Extra heavy Bolo Knife ideal for home, farm or jungle use. Blade of government formula. Cutlery steel. Walnut riveted handle. 3 1/2 inch hilt, 10 1/2 inch blade. You'll find hundreds of uses for a Bolo Knife. Makes a grand gift for a serviceman. Weight 2 pounds. **K112 \$4.95**
-WITH ARMY SHEATH
K112-LEATHER SHEATH, EXTRA \$1.50

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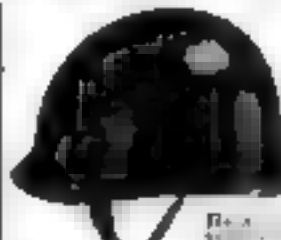


Specialty designed for Army use. Measures 2 x 16 x 3/4 inches. Calibrated in yards and meters. Reversible sliding segments. Orig. value \$20.00. **K121-EACH ONLY 98c**

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Waterproof acid and alkali proof. Used by industrial, photographic, florists, chemists, etc. Of salvaged balloon material. Great. **K123-LADIES each 98c**
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Reg. Tank Corps helmet. Adjustable head size. With chin strap. Used but perfect. **K-201, EACH 98c**

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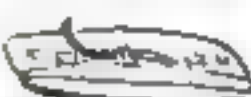
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Of rubberized khaki. 10x40 inches in size. Used as life belt, raft or air pillow. Inflated or deflated. Used guaranteed water tight. **K127 EACH 98c**

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Values galore! Hundreds of hard-to-find items for home, shop and outdoors at tremendous savings.

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Genuine wishbone type cavalry spurs. Nickel plated brass. **K-102, Pair 98c**
K-103 Spur straps per set of four 50c

MOSQUITO TENTS



Of malarialite with taped seams. Metal rods and bars included. Covers cut or hammock brand new. **K-104 EACH \$2.95**

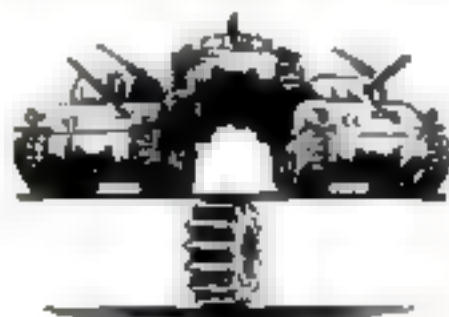
800 Ft. 16mm FILM CANS
Storage cans for 800 ft. 16 mm film. M. C. M. M. M. A. A. A. **K150 49c**



Half-inch Gear TOOTH in Cyclone Engine Transmits Power of 40-Passenger Bus



TRAFFIC COPS: One job of gears in Cyclone is to slow down propeller to an efficient speed. If blade tips turn too fast, get above the speed of sound, the propeller vibrates, loses power. In some models of Cyclone 18, the propeller turns over only 35 times for each 100 revolutions of crankshaft.



75 TONS PER INCH: Reduction gears in Cyclones are designed to withstand a load of 150,000 pounds per square inch — equal to the weight of three 25-ton tanks. All gears used in Cyclone engines are heat-treated for extra strength, then ground to an accuracy of two ten-thousandths of an inch.

Roaring down the runway, a giant bomber is thrust aloft by 8,800 horsepower from four Cyclone 18's. Inside each Cyclone, a set of gears feeds the great surging power from engine to propeller at the most efficient speed. One type gear in this set has teeth only a half square inch in area. Yet on every revolution, each finger-nail size gear tooth must handle 110 horsepower. This power is enough to pull a 40-passenger bus at top speed.

Like all other parts of Cyclone engines, gears must be giants in strength and midgets in size. Wright Aeronautical skill in gear making enables Cyclone engines to use smaller, yet stronger gears. That's one reason why Cyclones have the lowest weight-power ratio of any aircraft engines.

Write Today for "ENGINEOLOGY"
a 100-page booklet on the "Why" of engines

Write today for this complete but non-technical booklet on engines and their relation to planes and propellers. Describes operating principles of engines. Explains supercharging, combustion, ignition, carburetion. Now in its third printing. Just send twenty-five cents in coin (U.S.) to: Wright Aeronautical Corporation, Dept. PS, Paterson 3, New Jersey.



WRIGHT

AIRCRAFT ENGINES

WRIGHT AERONAUTICAL CORPORATION
A DIVISION OF CURTISS-WRIGHT CORPORATION

Target Kite Imitates Plane's Flight

By **ARTHUR GRAHAME**

Drawings by STEWART ROUSE

THE Army and the Navy have reached back 3,000 years into history for something to improve the shooting eye of their air gunners.

It's a kite—one that performs maneuvers no kite ever performed before. When the war is over it is going to be the delight of kids from seven to 70. A quarter of a million of the kites have already been produced for machine gunners to rip apart, and production is still going on.

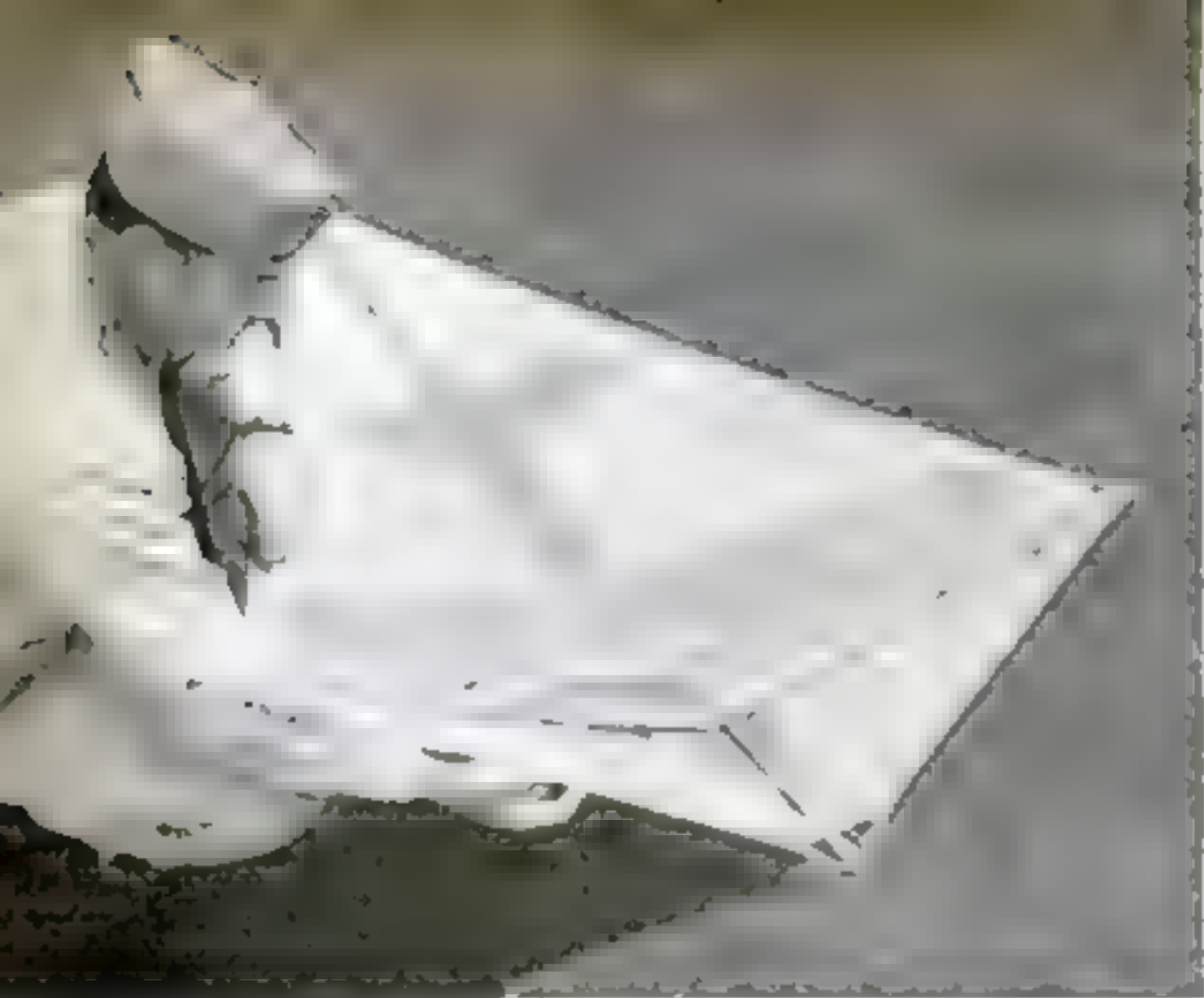
This kite will dive, loop, and bank sharply. It will plummet like a stricken airplane hurtling earthward with its engine at full power. It will recover with all the ease of a pilot hauling back on his stick, and race for altitude.

The Navy's kite—it was developed by the Navy and then adopted by the Army—is called the best air-gunnery target in the world. It was perfected by Paul Edward Garber, who probably knows more about kites than anyone else and who might be called the champion kite flyer of five continents.

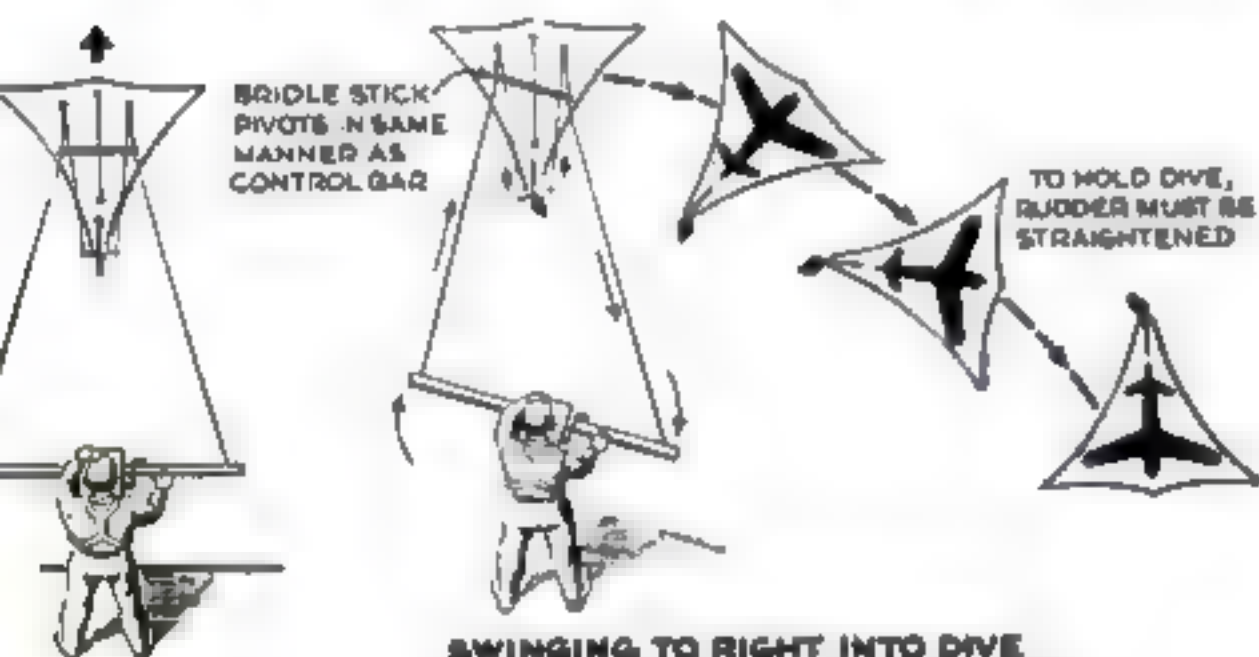
As curator of aviation at the Smithsonian Institution in Washington, D. C., he

Army and Navy AA gunners sharpen their eyes on a kite that simulates many maneuvers of an airplane in flight. Bearing a 1/9-size fighter-plane silhouette, it's called the world's best air-gunnery target.





FAMILIAR DESIGN. The remarkable air target has the traditional kite shape but is of durable construction. Five feet, one inch high, with a wing span of five feet, the standard model weighs under two pounds. Bolted to the mast—of $\frac{1}{4}$ by $\frac{3}{4}$ -inch spruce, pine, or basswood—is a $1\frac{1}{2}$ by $\frac{3}{4}$ -inch spar, nine inches from the top. The cover is plastic-treated rayon. Maneuvers are effected through a control bar as shown below, from the ground or from a ship's deck.

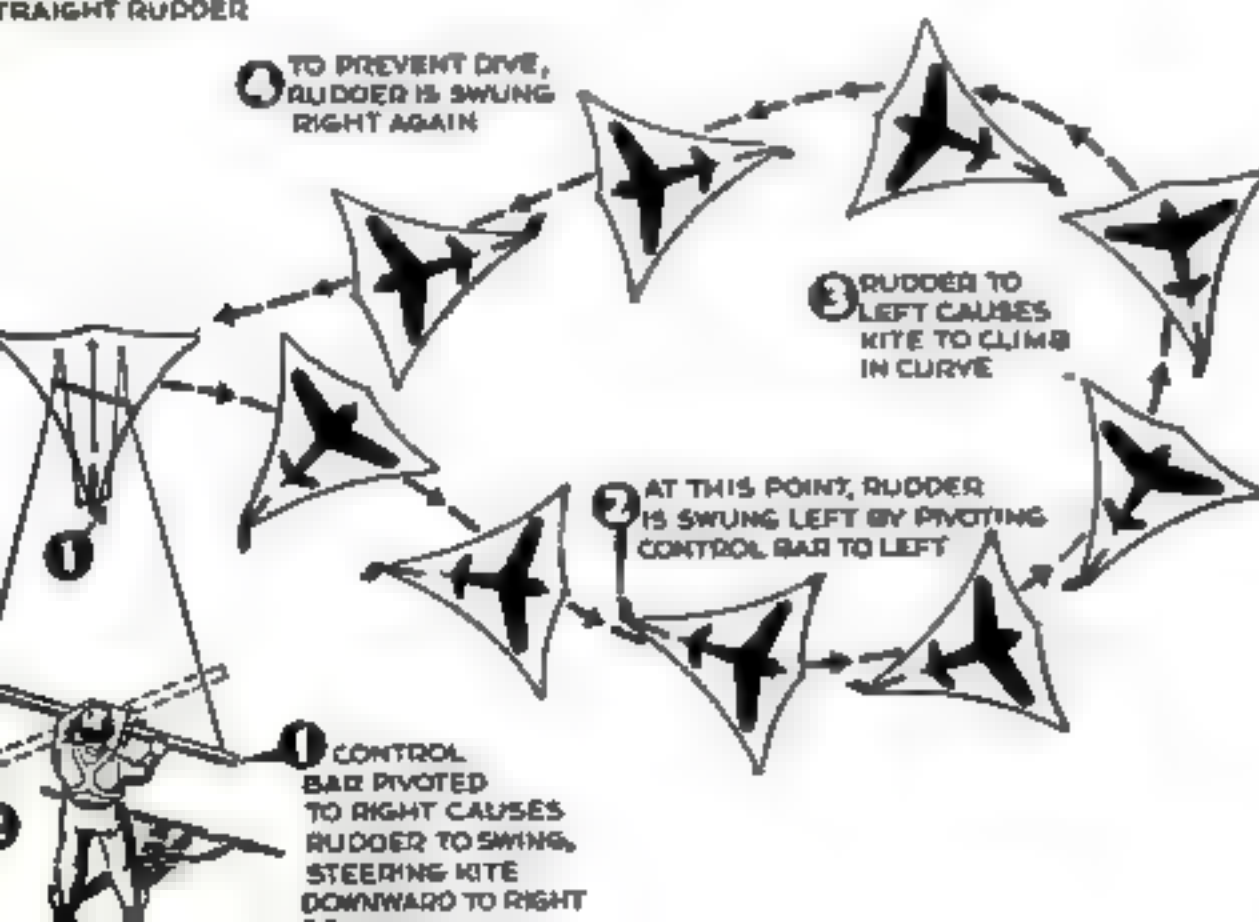


CLIMB
WITH CONTROL BAR
NEUTRAL AS SHOWN,
KITE CLIMBS TO ITS
FULL SPEED WITH
STRAIGHT RUDDER

BRIDLE STICK
PIVOTS IN SAME
MANNER AS
CONTROL BAR

TO HOLD DIVE,
RUDDER MUST BE
STRAIGHTENED

SWINGING TO RIGHT INTO DIVE
PIVOTING CONTROL BAR TO RIGHT SWINGS
RUDDER TO RIGHT. THIS STEERS KITE INTO
DOWNWARD SWING TO RIGHT, TURNING INTO
VERTICAL DIVE, HELD BY STRAIGHTENING
RUDDER WITH CONTROL BAR



1 TO PREVENT DIVE,
RUDDER IS SWUNG
RIGHT AGAIN

3 RUDDER TO
LEFT CAUSES
KITE TO CLIMB
IN CURVE

2 AT THIS POINT, RUDDER
IS SWUNG LEFT BY PIVOTING
CONTROL BAR TO LEFT

4 CONTROL
BAR PIVOTED
TO RIGHT CAUSES
RUDDER TO SWING,
STEERING KITE
DOWNWARD TO RIGHT

TARGET KITE used in enemy wa-
ters (left) is made with an aluminum-
alloy frame that sinks when shot
down. No floating wrecks of kites
are thus left behind to tip off the
enemy to the presence of our ships.

was custodian of the museum's
kite collection, which ranged
from weird oriental kites rep-
resenting gods and demons to
the box kite capable of carry-
ing a man aloft, invented by
Lawrence Hargrave, of Eng-
land.

Garber knew that kites, no-
tably a type invented by Alex-
ander Graham Bell of tele-
phone fame, had exerted a pro-
found influence on early air-
plane design. He had studied
kite shapes and their flying
qualities from information cov-
ering a period of 30 centuries.

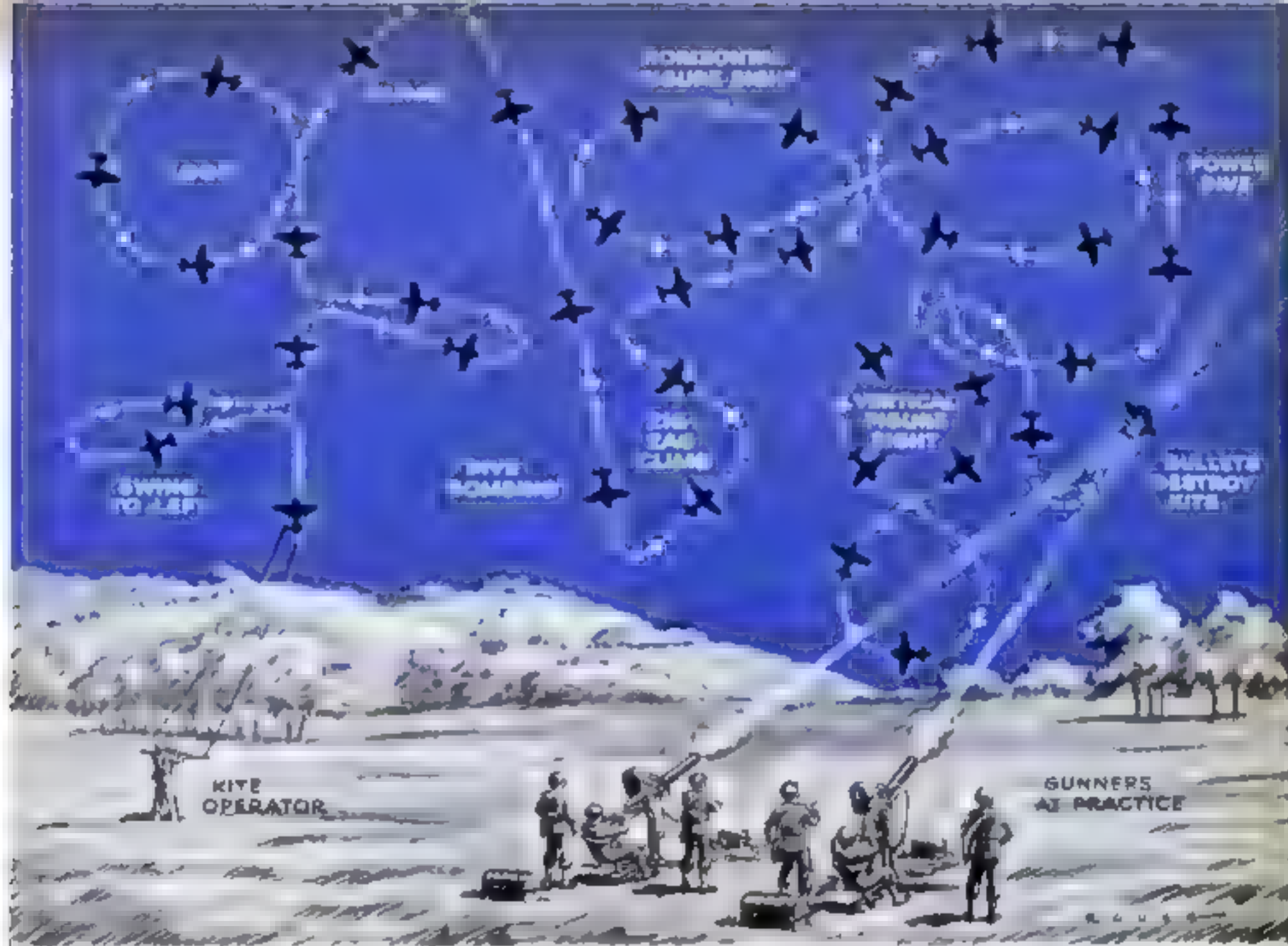
Shortly after the United
States entered the war, Garber,
now a lieutenant commander
in the Special Devices Division
of the Navy's Bureau of Aero-
nautics, heard Admiral John
H. Towers remark that one of
the things the Navy needed
most was an improved moving
target to speed up the training
of aircraft gunners.

Garber tucked that remark
away in his head. At that time,
he was helping with the pro-
duction of millions of model
airplanes needed by the armed
services for recognition in-
struction.

Garber kept thinking about
targets. A kite might do. It
would be cheap, easy to pro-
duce. But if it was stationary
in the air it would be an easy
mark for even a novice with a
gun. What was needed was one
that would do aerobatics and
dodge bullets.

Working in hours mostly
stolen from his sleep, and as-
sisted by Lloyd Reichert and
Stanley Potter, fellow kite en-
thusiasts, Garber perfected his
target kite in a little less than
a year.

He used as a basis for his
kite—which is without a tail
—one with a bowed cross spar
developed from a Malay kite
half a century ago by an
American experimenter, Wil-
liam A. Eddy. Garber was after
stability; this kite had it.

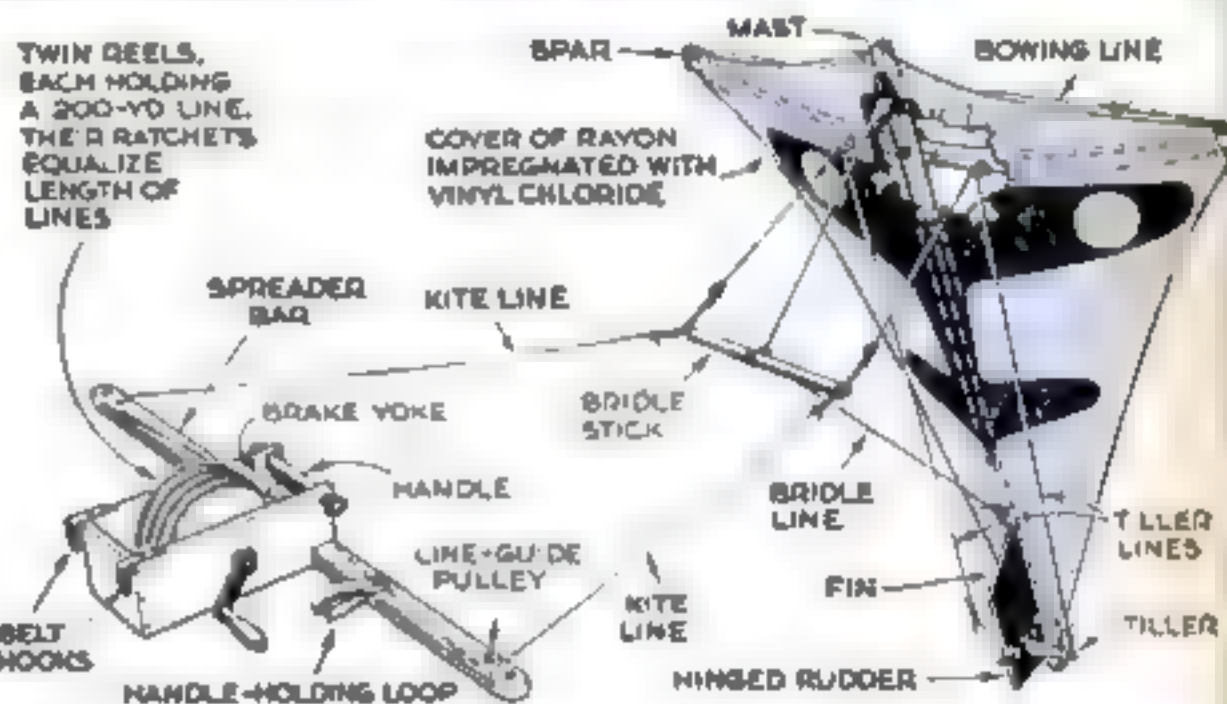


KITE STUNTS. After a half hour of instruction and a few hours' practice, an operator can make this wonder kite perform all sorts of spectacular aerobatics.

When the wind presses against the covering fabric, the lower portion of the kite becomes a sort of vertical keel. The bowed spar becomes a weight-carrier similar to that of the bony structure of a bird's wings. Lateral balance can be destroyed and restored simply by altering the air pressure on one side or the other of the face of the kite. Garber added a fin near the lower end of his upright mast to augment the keel surface. To this he attached a rudder, controlled by the kite's operator by means of twin flying lines.

When he was satisfied with his product, Garber demonstrated it for Capt. Luis de Florez, Chief of the Special Devices Division, who in civilian life is a successful inventor and consulting engineer. Captain de Florez watched the kite's spectacular aerobatics for a few minutes.

"That's fine," he said, with a cheerful disregard for Navy red tape. "Get 1,500 made



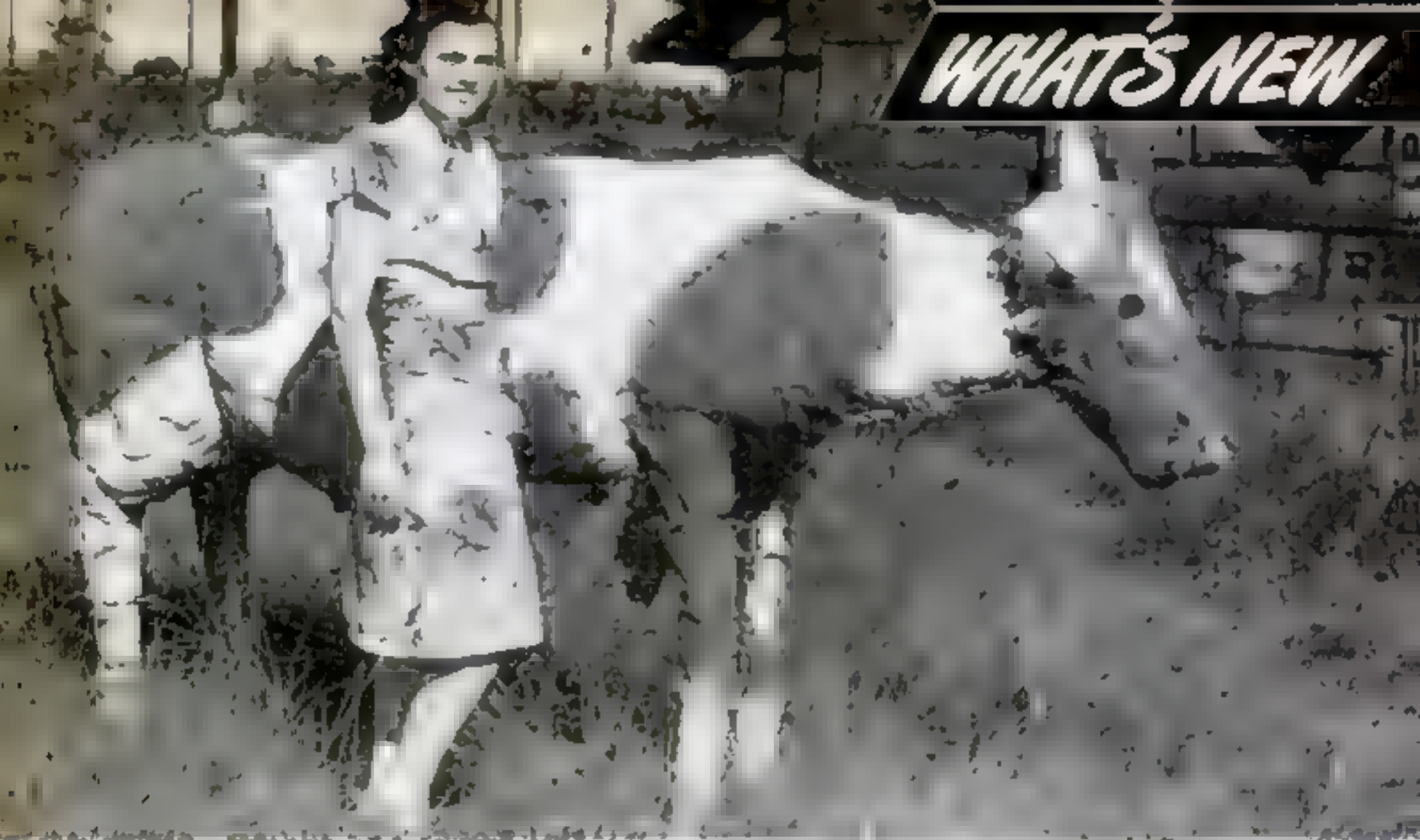
This control mechanism "pilots" the kite. A two-drum wood reel with brakes is mounted on the four-foot bar. The flying lines are led to the kite through the 12-inch-long bridle stick which, with the keel and dihedral, gives the kite three-dimensional stability.

up." Demonstrations to other Navy officers and to the Army were enough. The Garber kite was adopted.

The kite must be good. Gunnery officers are elated when their students hit it once in 50 shots.

What the target kite will do to peacetime kite flying is easily imagined. Appropriately, it is being manufactured for the armed forces by A. G. Spalding & Bros., makers of athletic equipment.

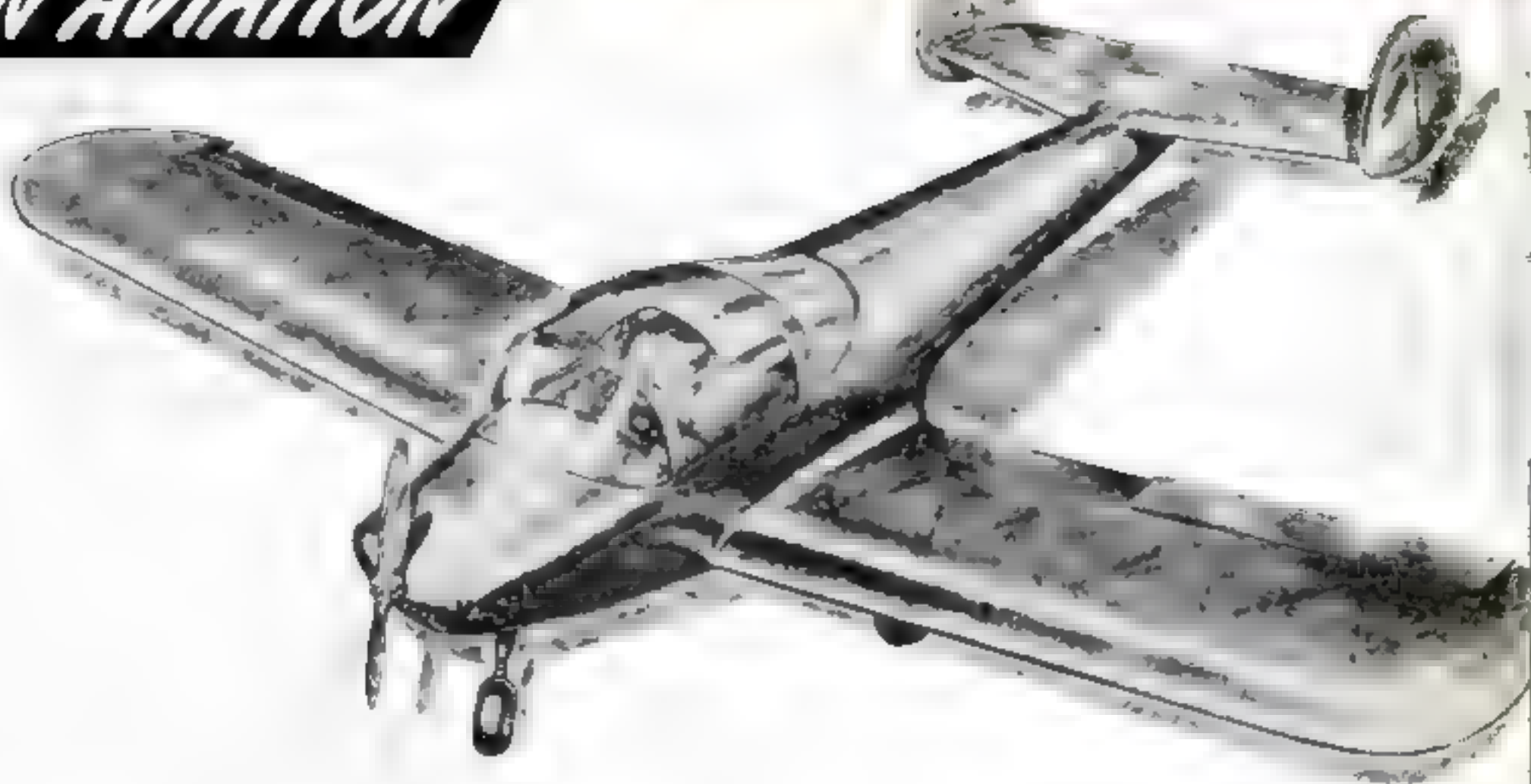
WHAT'S NEW



COWS SCARED OFF NAZIS —and dummy cows, at that! The Russians put camouflage animals like this on sledlike runners and placed them in open fields to keep German planes from landing. (No sensible flyer will come down in a field occupied by animals, which would be sure to stampede into the path of the plane.) The cows' tails also served as handy wind socks for Soviet pilots. Eleanor Holm is seen in this USAAF photo.

THEY OPEN FASTER. Using a new source of power in the form of midget air-compressor systems weighing less than 10 pounds each, B 29 bomb-bay doors now snap open in seven tenths of a second. Fifteen seconds formerly were required with electrically driven gear mechanism. This improvement means faster bomb runs, easier bombsight operation, faster getaway, and lessened vulnerability to attack.





THE "CHUM." This two-place, twin-control, spinproof, low-wing plane will be built by Aerona for the postwar private flyer. Special attention has been given to insure safety. Powered by a 75-hp. engine, the Chum is designed to cruise at 106 m.p.h. with a top speed of 120 m.p.h. and a cruising range of 470 miles. The ship has a wing span of 29 feet, weighs 710 pounds empty, and can carry a passenger load of 590 pounds.

ROCKET-SPURRED TAKE-OFF.

Aided by rocket-propulsion units, British carrier-borne aircraft now can take off in light winds with heavier loads than formerly. An explosive charge of cordite in the rockets gives additional acceleration toward the end of the run and so reduces the take-off distance. One to four rockets mounted on each side of the fuselage are fired simultaneously. Right, a Seafire is primed with rockets.



LEAVE NO CRATERS.

A new type of bomb load—clusters of high-explosive and personnel bombs—gives close support to ground troops and explodes without causing craters which would impede the progress of the troops. Photo shows a load being fitted to a Typhoon fighter-bomber of the RAF 2nd Tactical Air Force. A canister holding 26 twenty-pound antipersonnel bombs is hooked onto the bomb racks, after which the nose and tail units are added. Each wing holds one load.



The Reaction Engine

TOMORROW'S POWER IS BASED ON NEWTON'S THIRD LAW OF MOTION

*"To every action there is always
an equal and contrary reaction."*

—SIR ISAAC NEWTON

. . .

THE invention of the wheel was so wonderful that men have devoted centuries to the creation of engines to turn wheels. Now, however, another invention has shown that more speed can be attained without wheels than with them.

Reaction motors are a new source of usable power. They can push without anything to push against, for they put Newton's Third Law of Motion (stated above) to work. Five distinct types of reaction motors have been developed—but few people know how they work, how they differ, or even what to call them.

POPULAR SCIENCE MONTHLY feels both obligated and pleased to introduce you to rocket power. This authoritative article is the first attempt in any language to show the relation of the various kinds of rocket power now in use. It corrects widespread misconceptions, defines terms that everyone soon will be using, and discloses the amazing possibilities of locomotion without wheels.

—THE EDITORS

By G. EDWARD PENDRAY

THE V-2 bombs exploding in England before they could be heard coming, the U. S. Navy's little zoom boats blanketing Japs with blast, and the U. S. Army's Shooting Star, jet-propelled fighter, outflying every other plane in the air have demonstrated anew a law formulated about 265 years ago by an Englishman who is said to have been conked on the head by a falling apple.

Sir Isaac Newton pointed out three laws of motion. The first is that bodies of matter do not alter their motion except as the result of forces applied to them. The second ex-

plains the relation of such forces to momentum and direction. And the third is: "To every action there is always an equal and contrary reaction; the mutual actions of any two bodies are always equal and oppositely directed."

The first two laws cover the motions of both an oxcart and a B-29. Men looking for action have tended throughout history to neglect the reaction, or to use it only incidentally. But the creators of new weapons of war have found now that, because of Newton's third law, it often pays to throw away the action and use the reaction. That is the secret of rocket power.

For good or ill, the inventors' new appreciation of this old fact of dynamics is certain now to bring about changes that will affect the life of every person in the world.

The purpose of an engine is to change the chemical energy of a fuel into some useful mechanical motion. Steam and gasoline engines convert the energy of coal or oil into rotary motion. We must familiarize ourselves now, however, with an entirely new kind of engine. It uses chemical energy but, instead of rotary motion, it produces a straight, powerful thrust. It has no cams, gears, pistons, crankshafts, or connecting rods, and need not be attached to wheels or a propeller, because it does not "roll"; it just "goes," and whatever is attached to it goes along.

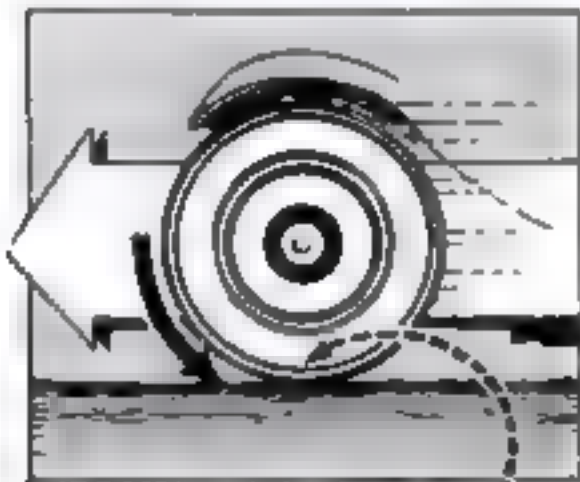
Such an engine is a reaction motor. It is thrust forward by the reaction to the action of a jet of gas. Hence, the principle of the reaction motor is known as jet propulsion.

People often presume that the jet drives a rocket forward by pushing against the air. That is impossible. Gas consists of billions of pellets, or molecules, that are not connected in any way. They tend, in fact, to dart away from each other as fast as

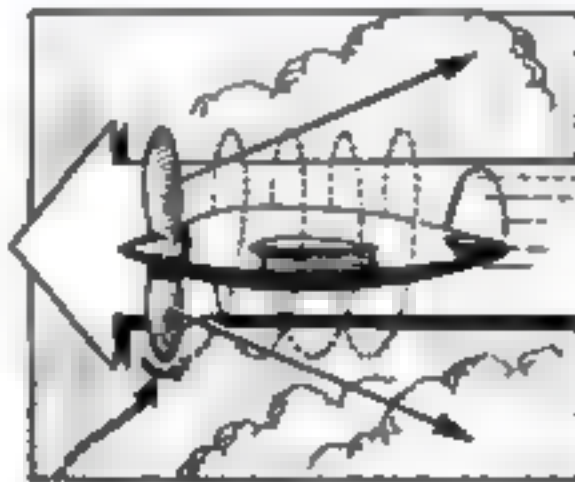
HOW NEWTON'S LAW IS APPLIED. Up to now, men have moved their vehicles by harnessing the action produced by releasing the chemical energy stored in fuel, throwing away the corresponding reaction. Now we have learned that it sometimes pays to throw away the action and utilize the reaction. That's rocket power.



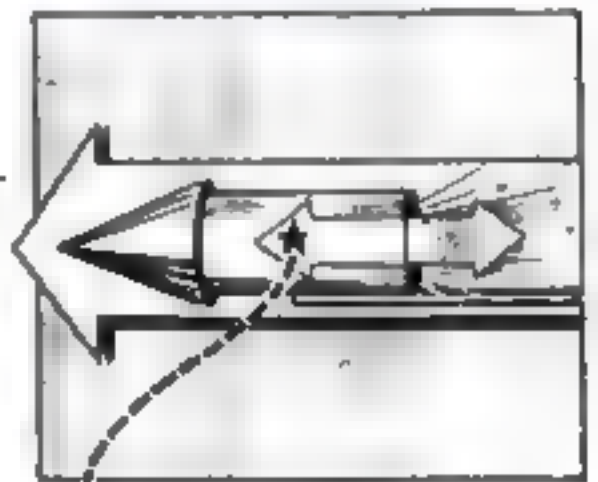
FOUR AGES OF TRANSPORTATION. First, wheeled vehicles were moved by human or animal power. Then engines were harnessed to wheels for traction. With the coming of the air age, rotary motion was still used to turn propellers and drag planes through the air. Now comes the reaction engine.



TRACTION
(WHEEL AGAINST SOLID)

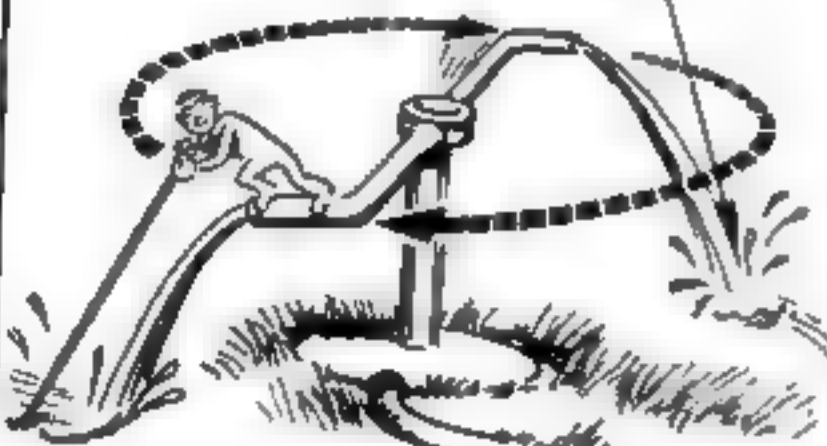


PROPULSION
(PROPELLER AGAINST AIR)



REACTION
(REACTION AGAINST
ACTION OF OWN GASES.)

THE REVOLVING SPRINKLER
DOES **NOT** USE THE STREAM
AS A "PUSH-ROD" TO PUSH
AGAINST THE GROUND...



IT WOULD STILL TURN WITHOUT ANY
EARTH OR AIR TO PUSH AGAINST!

AND THE ROCKET DOES **NOT** PUSH
AGAINST THE ATMOSPHERE TO
GAIN ITS FORWARD MOTION

THAT'S A MISCONCEPTION

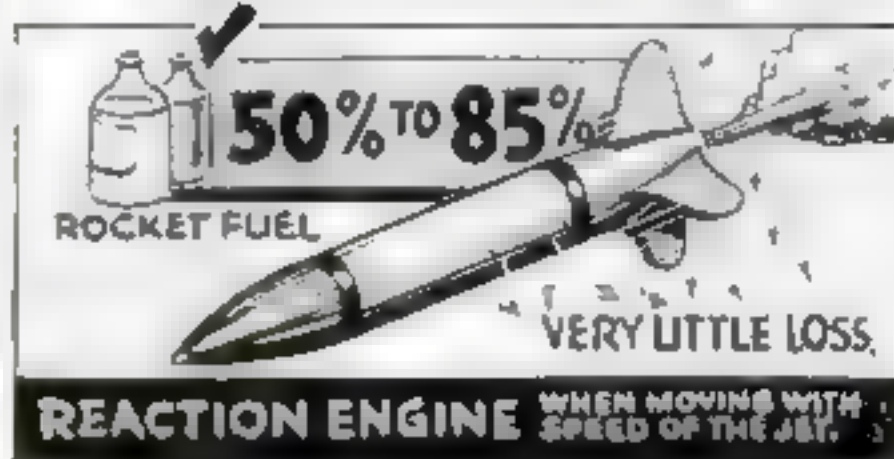
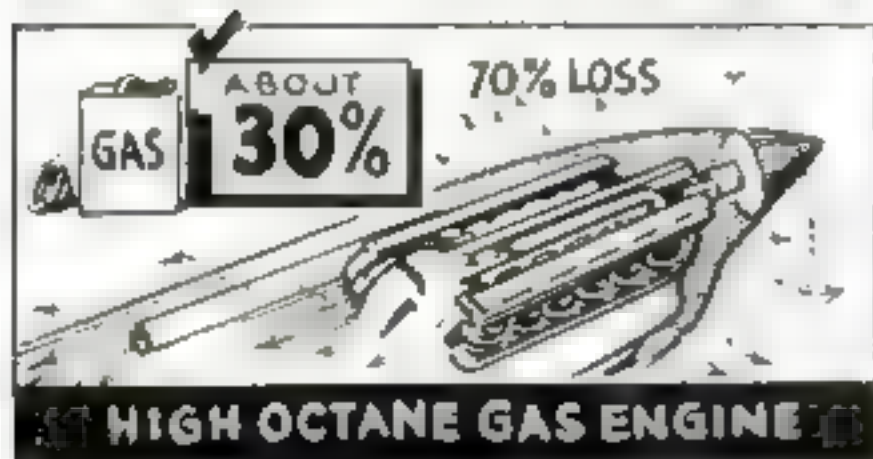
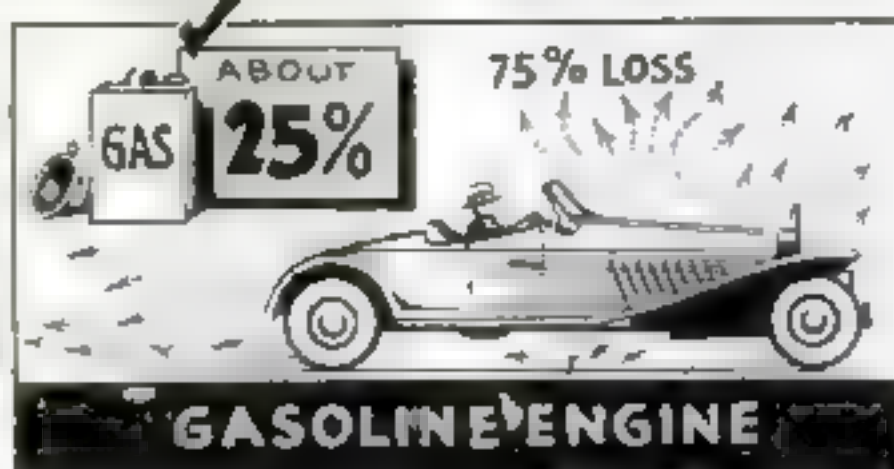
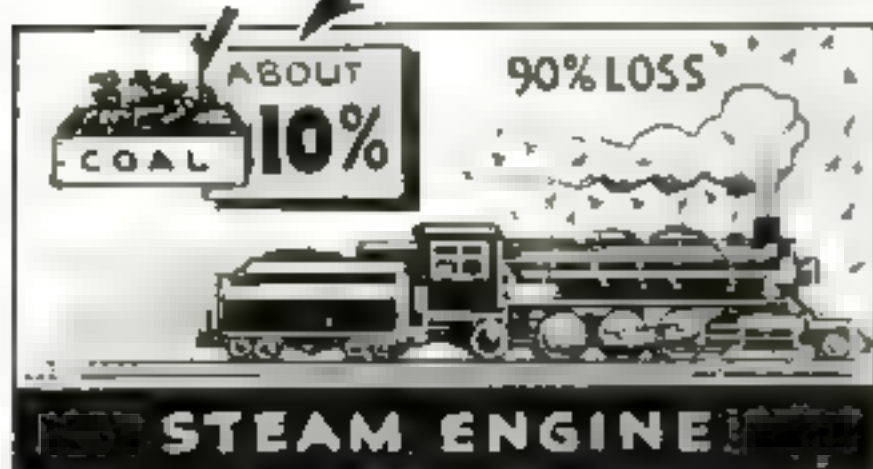


REACTION = ACTION

..... IN FACT THE ATMOSPHERE
IMPEDES THE ROCKET BY
DRAG, FRICTION, TURBULENCE,
ETC

REACTION MOTOR, LIKE ALL ENGINES, EXTRACTS HEAT ENERGY AND TURNS IT INTO MECHANICAL ENERGY. HERE ARE SOME POWER PERCENTAGES.

PERCENT OF HEAT TURNED INTO MECHANICAL POWER AT POWER PEAK



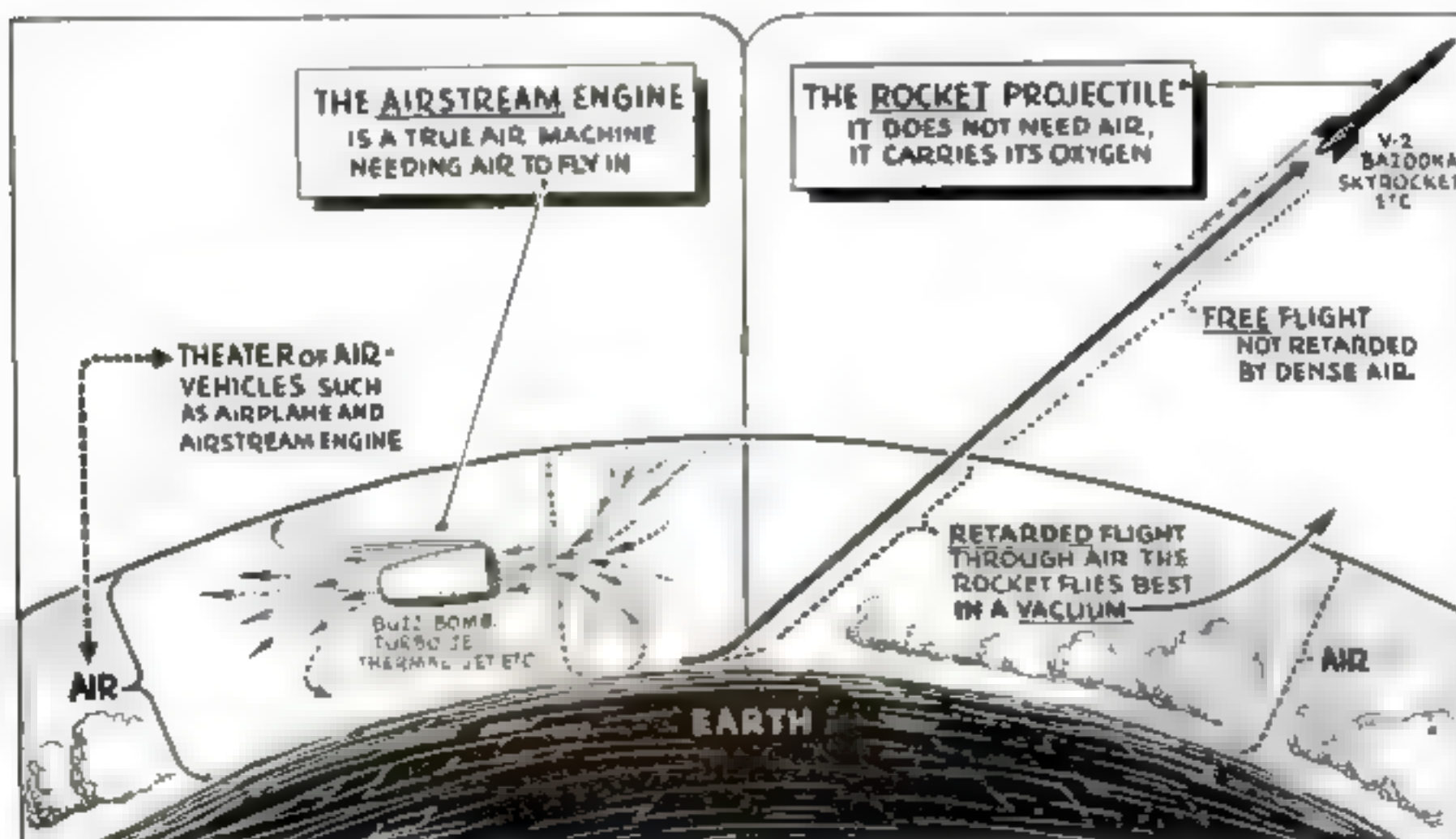
possible. The air also consists of random, flying molecules. When a molecule of gas bumps into a molecule of air, both go off in different directions with altered speed. But how could even thousands of billions of such collisions between loose molecules drive a rocket that is not connected to them—drive it, moreover, in a specific direction?

A stream of gas, no matter how fast it

moves or how dense it may be, is not a solid connecting rod capable of pushing against something and transmitting the push back against whatever is adjacent to its other end. So you could no more move a plane by pressing against the air with a jet of gas than you could row a boat with a liquid oar.

The air is a resisting medium. It inter-

AIRSTREAM ENGINE vs. ROCKET. All reaction motors depend on combustion, and you can't have combustion without oxygen. Airstream reaction engines take their oxygen from the air, and so cannot operate outside the earth's atmosphere. Chemical-fuel reaction motors (rockets), on the other hand, carry their own oxygen with them in combination with their fuel, and so can fly freely at great heights.



ALCOHOL

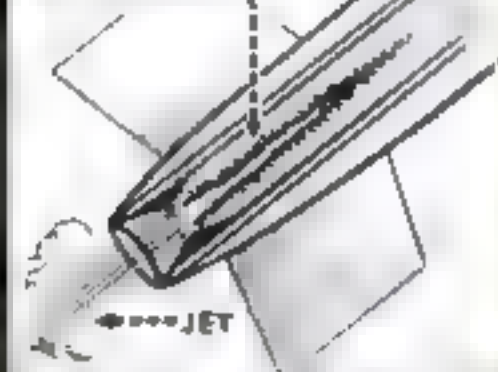
COOLING ALCOHOL
GOES THROUGH
DOUBLE-WALLED
CASING
BEFORE GOING
INTO THE
BURNERS

COMBUSTION
CHAMBER

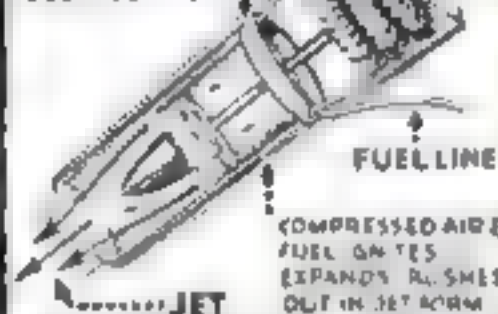
JET

OXYGEN

DRY FUEL SUCH
AS CORDITE



ROTORS
TO COMPRESS AIR
FUEL INJECTION



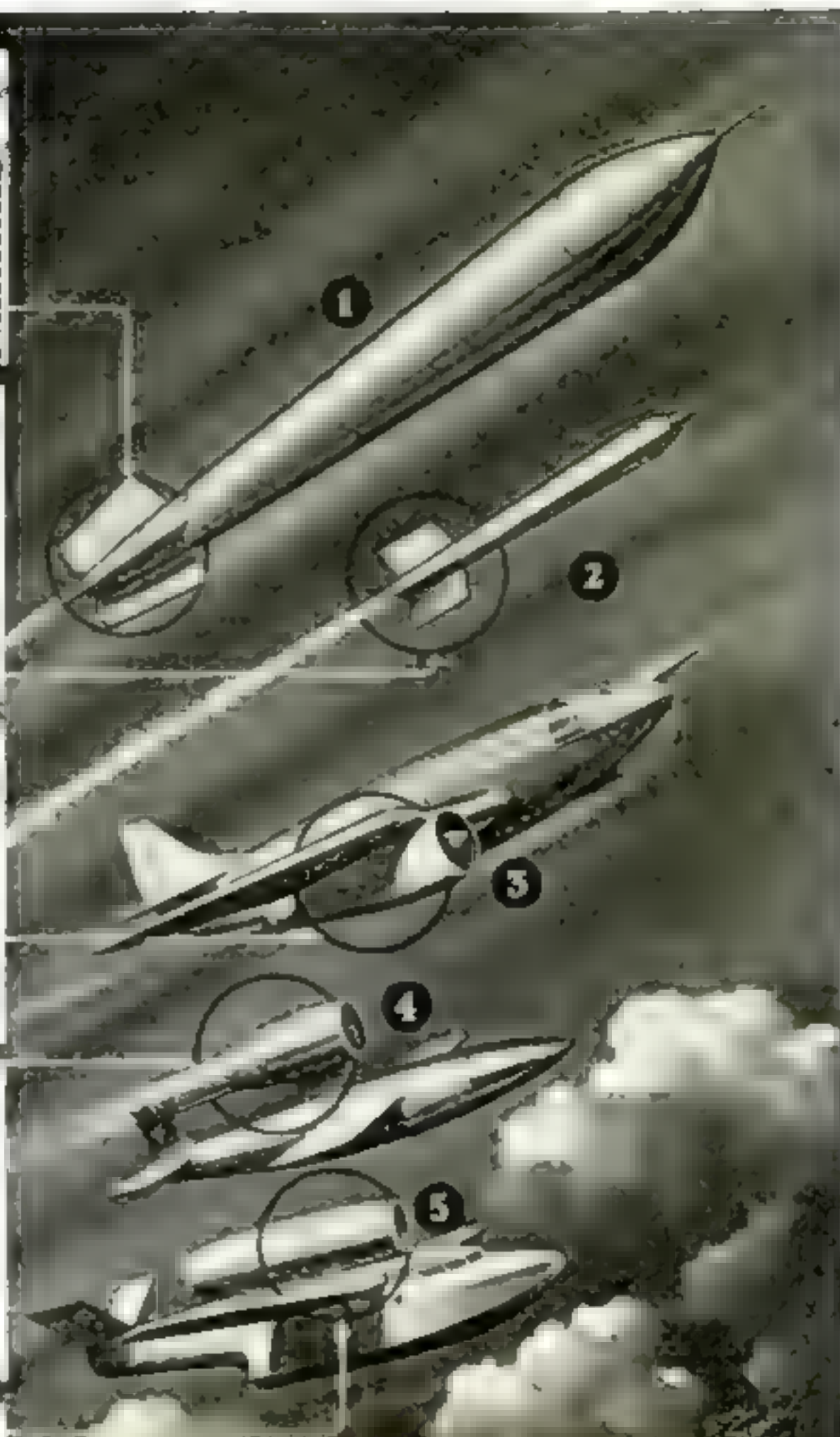
AUTOMATIC SPRING
SHUTTERS CLOSE
FOR EACH EXPLOSION

RAM EFFECT
COMPRESSES
ITS OWN AIR



CONTINUOUS IGNITION

CONTINUOUS
FLOW OF
EXPANDED AIR



Chemical-fuel Motors

LIQUID FUEL ROCKET

(V-2) Burns alcohol gasoline, or other fuel with liquid oxygen

DRY FUEL ROCKET

(Skyrocket, bazooka)

THERMAL JET ENGINE

(Turbo jet plane) Burns liquid fuel

INTERMITTENT DUCT ENGINE

(V-1) Burns liquid fuel. Air intake synchronized with expansion

CONTINUOUS DUCT ENGINE

Experimental "blowtorch" motor

Airstream Engines

FIVE TYPES OF REACTION ENGINES include two of the chemical-fuel (rocket) variety, three airstream jobs. The drawings at left, above, illustrate their respective operating principles. Most jet planes use the thermal jet airstream engine (No. 3); one German plane has a liquid chemical-fuel motor (No. 1). The continuous duct engine (No. 5) has appeared so far only in experimental form. No. 1 powers Germany's V-2 rocket bomb; No. 2, our bazooka projectile; No. 4, the Nazi V-1 "buzz bomb."

feres with both the escape of the gas from a rocket and the forward motion of the rocket, but it does not help drive the rocket. The thrust is the reaction to the ejection of the gas.

Lest this still not be clear, suppose that a lot of gas were locked in a box. The pressure of the gas would be the same against all sides of the container, so the box would not move. But, if a hole were cut in the left side, the gas would rush out. The pressure on the left side of the box would then be less than the pressure on the right side, so the box would jump to the right.

Both the gas and the box would be retarded by the atmosphere. But, if not retarded in any way, a light box could move as fast as the gas.

By putting a nozzle in the hole, to direct and control the expansion of the gas, the speed of the jet and the box might be increased. Then, if arrangements were added to replenish the supply of gas, the box would be a crude reaction motor. Replenishing the gas, however, would require fuel.

One of the most common—and mistaken— notions about rocket power is that the fuel question is the principal obstacle to its further development. Nothing could be farther from the truth. Reaction motors need no special fuels. Research, of course, will undoubtedly result in the discovery of better fuels and better combinations of fuels, but the fuels needed for the coming age of rocket power are already at hand.

Reaction motors will run on kerosene, gasoline, or alcohol; on gunpowder, powdered metal, or coal dust dissolved in oil; or any of a long list of other compounds. A fuel is simply something from which the motor can extract energy.

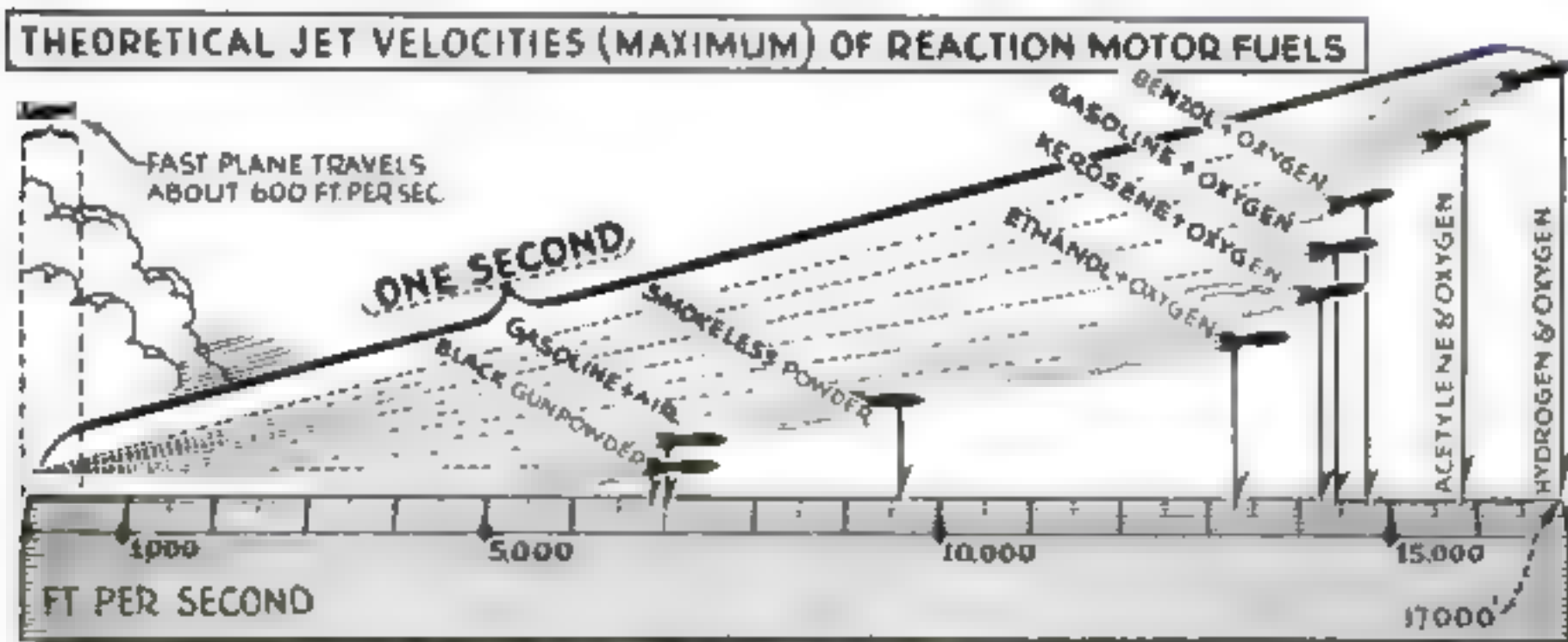
Directly or indirectly, all the energy on the earth, except that from radioactive materials, has come from the sun. Energy has been stored in the molecules of certain chemical compounds by *endothermic*, or heat-absorbing, reactions. It can be released by *exothermic*, or heat-releasing, reactions. When this is done at exactly the right time, place, and rate, a jet is produced.

But oxygen is needed to bring about exothermic reactions, and reaction motors are classified according to the way the oxygen is obtained. It may be fed to the motor in chemical compounds, in the molecules of the fuel itself, or in a compressed and liquefied form after having been separated from the other gases of the air. When the oxygen is supplied in any of these ways, the reaction motor is called a *self-contained*, or *chemical-fuel*, motor.

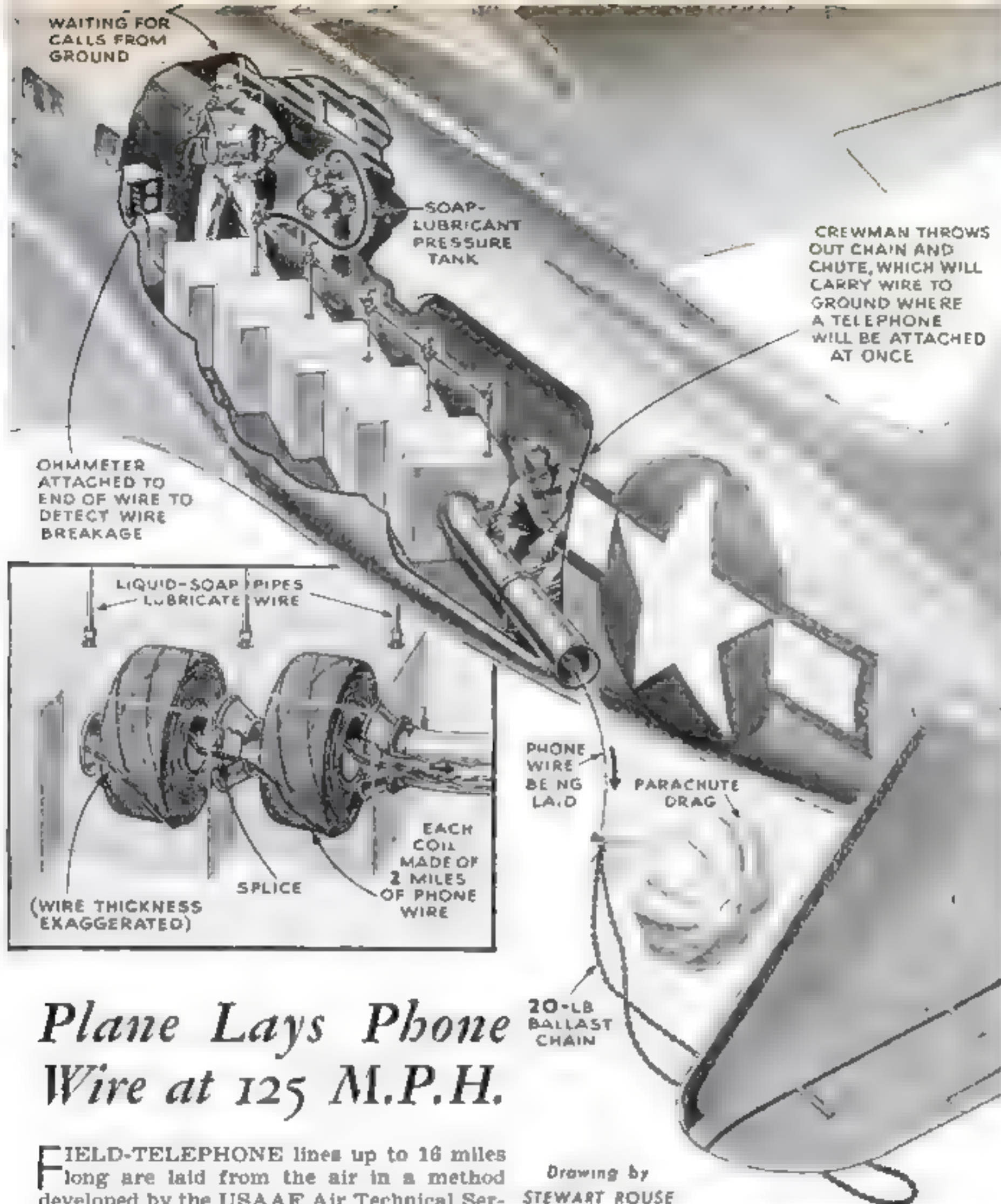
About a fifth of the earth's atmosphere is oxygen, so it is possible also to bring about the desired combustion of fuel by simply using air, and when this is done the reaction motor is called an *airstream engine*. To discuss rocket power intelligently with an engineer, you must remember the difference between chemical-fuel motors and airstream engines.

A chemical-fuel motor may use either a *dry* or a *liquid* fuel. Gunpowder and smokeless powder are examples of the former; Fourth-of-July skyrockets and bazooka projectiles contain dry-fuel motors. These are the simplest of all reaction motors, for they consist of nothing but a cavity in the fuel, an orifice, and a nozzle.

The German V-2, however, was driven by a liquid-fuel motor. This type is still in its infancy, but is susceptible of startling development. (Continued on page 816)



FUEL presents no special problem, as suitable substances are now available. Since efficiency is highest when flying speed equals jet velocity, slower fuels must be used for aircraft, which are limited to speeds around that of sound. To compensate for this reduction in the speed of the jet, its volume is increased.



Plane Lays Phone Wire at 125 M.P.H.

FIELD-TELEPHONE lines up to 16 miles long are laid from the air in a method developed by the USAAF Air Technical Service Command in co-operation with the Bell Telephone Laboratories.

How this is done is shown in the drawings by Stewart Rouse. The wire-laying plane, a C-47 cargo carrier, flies low at a speed of about 125 miles an hour. When all the wire has unwound, the loose end drops across the point chosen for the end of the line.

Important military use is foreseen for the system in providing instant communication for units separated by rough terrain.

Men on the ground talk with the wire-laying plane, using a field-telephone set hooked to the free end of the line. On the ground are the chain and its three-foot parachute.



DETECTIVE MAGNET helps to catch criminals. It is made of permanently magnetized Alnico, and is shown being demonstrated by Charles M. Wilson, director of the Chicago Police Scientific Crime Detection Laboratory. Weighing 35 pounds, it can lift up to 175 pounds of weapons from underwater caches.



TEST

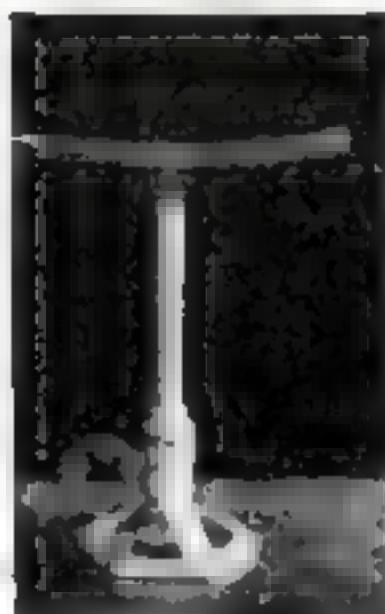


RUBBER-JACKETED CABLE

RESULT



TEST



NEOPRENE-JACKETED CABLE

RESULT



FIRE-RESISTANT INSULATION. In place of inflammable rubber as a coating for wires and cables, Neoprene is now used as a flame-resistant jacket for electrical wiring on shipboard. The pictures above show the comparative effect of fire on natural and on synthetic-rubber coating.

TROPICAL ICELAND?

Stately palm trees give a cozy look to the officers' club of Squadron VP-73 at the Fleet Air Base in Reykjavik, Iceland. The trunks are old pipe wrapped in burlap, and leaves are cut-up tin cans. Anchors are real. Photo from SKYWAYS.

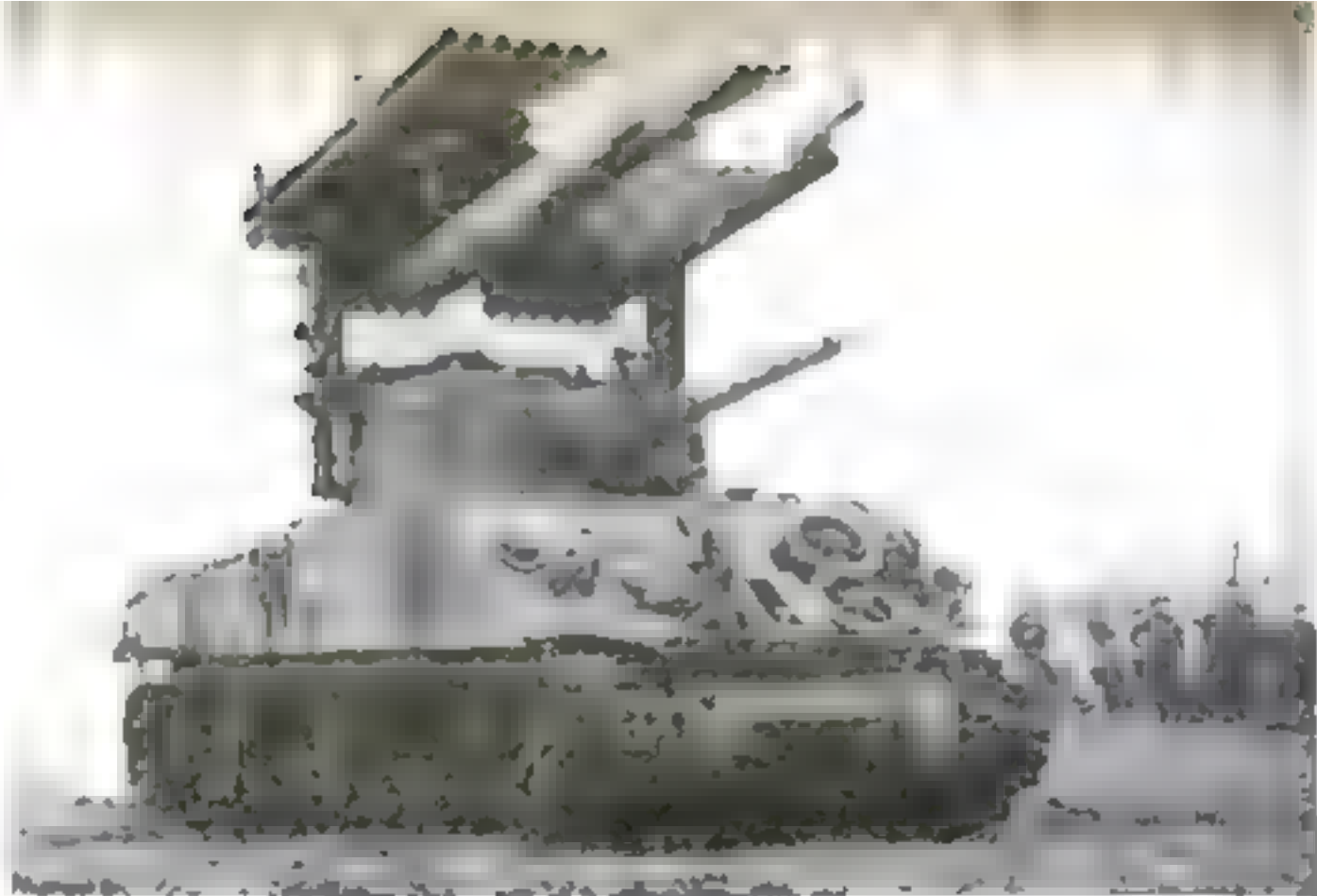




A-26—A NOSE FOR EVERY JOB

Designed for anything from straight bombing to every kind of attack and strafing mission, the Douglas A 26 Invader attack bomber is built to take on six different noses. The one pictured here mounts a 75-mm. cannon. These conversions, which include a bombing "greenhouse" and various combinations of guns, make the A-26 the most versatile U. S. ship

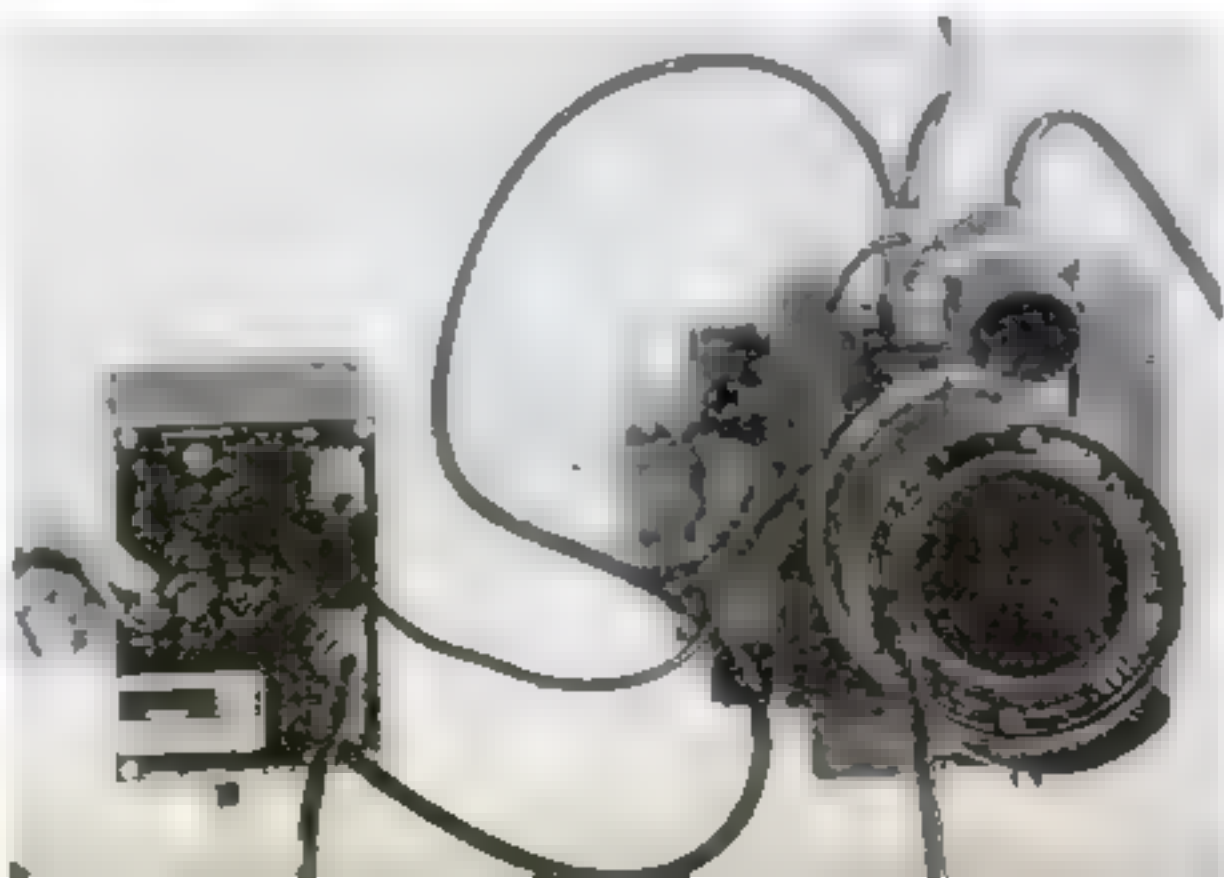
G1 "CALLIOPE" is whistling a tune of death and destruction to the enemy. This 60-tube rocket-launcher rack mounted on a General Sherman tank fires 4 5-inch, 38-pound missiles with the destructive effect of 105-mm. shells. The 60 rockets may be fired in 30 seconds and the launcher jettisoned. Then the tank roars in with its 75-mm. gun to finish the job.



TRAVEL COMFORT on trains is to be emphasized through the use of this new "chaise-longue" seat. It has a scientifically constructed cushion that conforms to body contours, and cars so equipped become "day-night" coaches. In its upright position it is a restful coach seat. But when the back is reclined and a full leg rest, which is built flush into the seat ahead, is released, the passenger enjoys the comfort of the last word in train travel by coach. The seat is one of the many new features that the nation's railroads will offer the postwar traveler to make a long journey a pleasing and restful experience instead of a dull, fatiguing ordeal.

FLASH-BOMB SHUTTER. A photoelectric grid shutter, electronically controlled, that reacts only to the light of a flash bomb, has been used by our aerial photographers to "shoot" bombings and enemy troop movements at night since before the Normandy invasion. The shutter, shown closed on camera at right, below, and open at left, was developed by Graflex in co-operation

with the General Electric Company. It reacts only to the light of a flash bomb and is insensitive to illumination of searchlights, bursting flak, and ground fires.



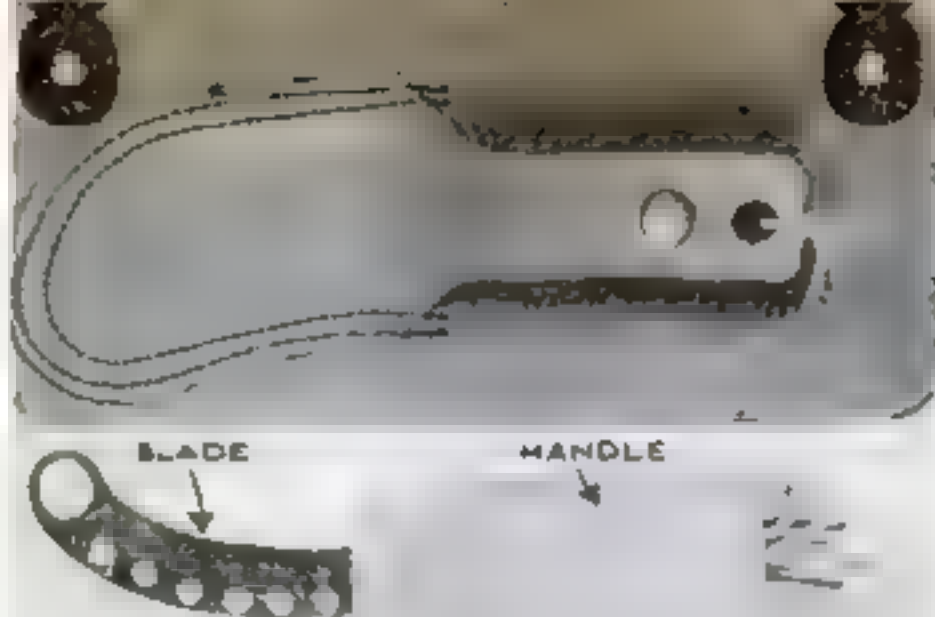
Half-Billion-Candlepower

flash bomb is secret weapon that lights up large sections of enemy terrain for night photographing, and blinds antiaircraft gunners for 20 minutes. Picture below, a marvel of pin-point detail, shows a rail yard at German Trier, where 900 freight cars were massed.





"VOLCANO" BOMB, biggest ever used, is 10 times as destructive as the German V-2 rocket. Only one plane—the British Lancaster—can lift this giant missile, which is 25 feet, 5 inches long and weighs 11 tons.



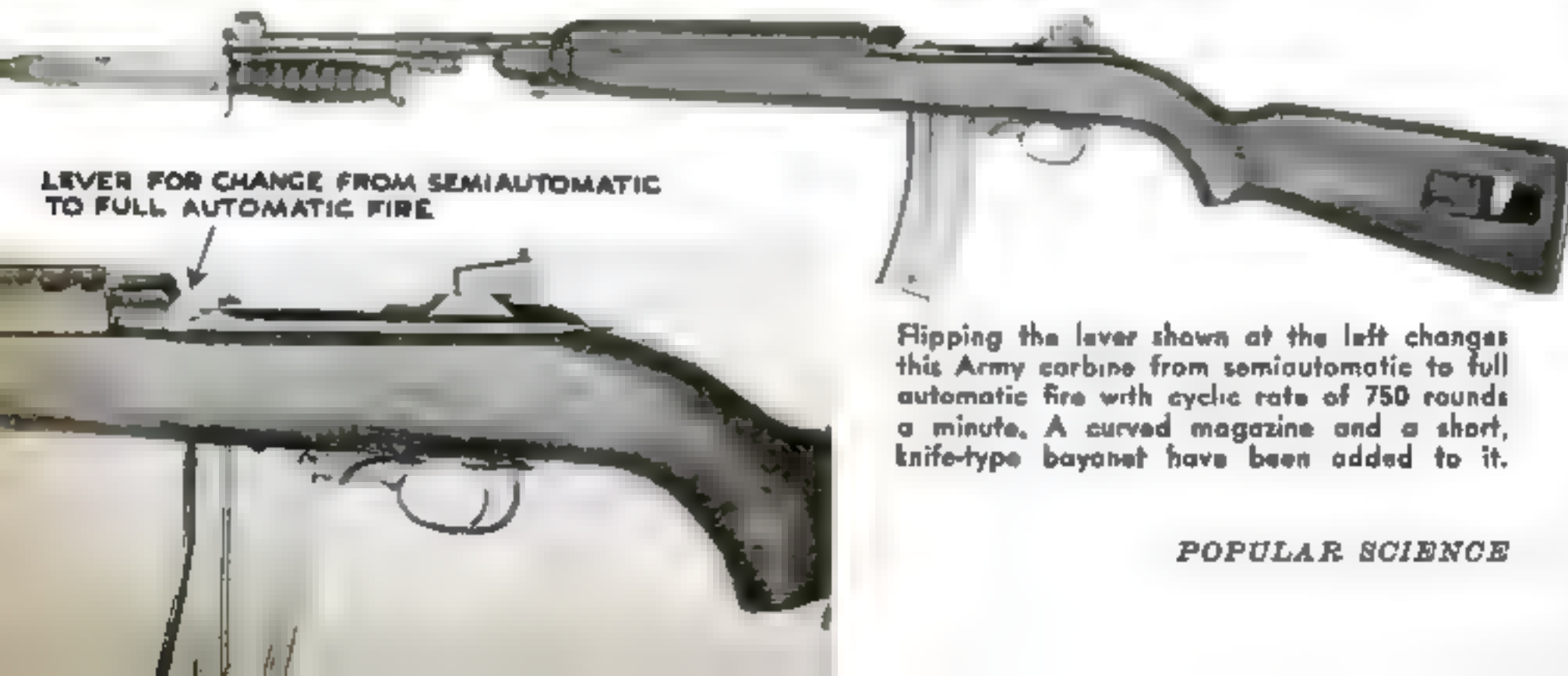
EMERGENCY KNIFE for cutting heavy flying clothes off wounded airmen has been developed by the Air Technical Service Command. A two-inch curved blade, drilled to reduce the weight, is mounted in a wooden handle that will float. Equipment includes a leather sheath.

MEDICAL BADGE is awarded to members of the Medical Department, U.S. Army, who have been attached to the Infantry in combat.



AUTOMATIC CARBINE. The Army's famous carbine has been adapted to full automatic as well as semiautomatic fire. Either type of operation is selected by the user by moving a lever above the new

curved magazine. Automatic fire is at a cyclic rate of 750 rounds per minute—so fast that the last of the 30 shots is fired before the first empty shell hits the ground. Note the short trench-knife bayonet.



LEVER FOR CHANGE FROM SEMIAUTOMATIC TO FULL AUTOMATIC FIRE

Flipping the lever shown at the left changes this Army carbine from semiautomatic to full automatic fire with cyclic rate of 750 rounds a minute. A curved magazine and a short, knife-type bayonet have been added to it.



Rescue squad of the Panama Coast Artillery Command brings back a radio-controlled target plane which was downed by machine gunners and AA men. An overhauling will make this ship ready to fly again.

"Junior Crash Boats" Rescue Remote-Control Target Planes

EIGHT seafaring soldiers of the Panama Coast Artillery Command have saved Uncle Sam close to \$100,000 during the past year by retrieving eight out of every ten ground-controlled target planes shot down by machine gunners and ack-ack men at their station. They brave the choppy Pacific in a flimsy 16-foot, oar-powered crash boat to rescue the bullet-peppered robots.

When they recover an aerial zigzagger they rush it to a hangar where they administer mechanical first aid. More often than not, however, a "hornet" requires a complete overhauling. After the preliminary job done by the sea-going grease monkeys, a crippled robot usually is shipped inland to a repair shop. Bullet holes in gas tanks are welded, and the control mechanism and failing motors are doctored. Also, wing struts are changed, and new fabrics are grafted upon perforated fuselages.

According to Lt. Chester W. Silkworth, of Brooklyn, Mich., in charge of the rescue detachment, ten crashes are about as many as a plane will survive.

Eighty percent of the dunted ships are recovered, despite the hazards of the sea and an unwieldy, water-filled parachute (below). Just as soon as a plane is landed, gasoline is poured over the sea-soaked engine (right) to stave off corrosion.





U S ARMY KEEPS WAY CLEAR in all kinds of weather for the supply trains that are moved on the front by the Army Transportation Corps. The plow shown above was made at a shop attached to a locomotive by an Army Railway Shop Battalion. It is capable of clearing away a 14 inch snow drift on a 2 1/2 per cent grade.



GAUGE TESTER was donated by Germany. This tricycle is being put to practical use by a first sergeant of the Transportation Corps somewhere in France. Wherever possible, captured enemy equipment is used to aid in the repair of railroad yards and tracks. Operation of the gauge tester prevents accidents by spotting even slightly spread or cramped rails.

FOR SWITCHING operations in France, this German rail truck salvaged by the Army from what was left behind in a hurry fills the bill. Fitted with heavy flanged wheels to hold the track, and efficient bumpers for pushing the truck is equal to most of the jobs that are usually done by a switch engine.





TROUBLE FOR TOKYO. Here's a unit of Admiral William F. Halsey's Third Fleet, which has caused an epidemic of headaches in Japanese naval circles recently. Leading the parade is an Independence-class carrier followed by an Essex class flat top, three lumbering battleships, and three heavy cruisers.

DRY DOCK AT SEA. One of our floating ship-repair units (P.S.M., Oct. 44, p. 82) plows the waves as it follows the fleet to a new island base. The blocks on its deck will support damaged ships' keels.

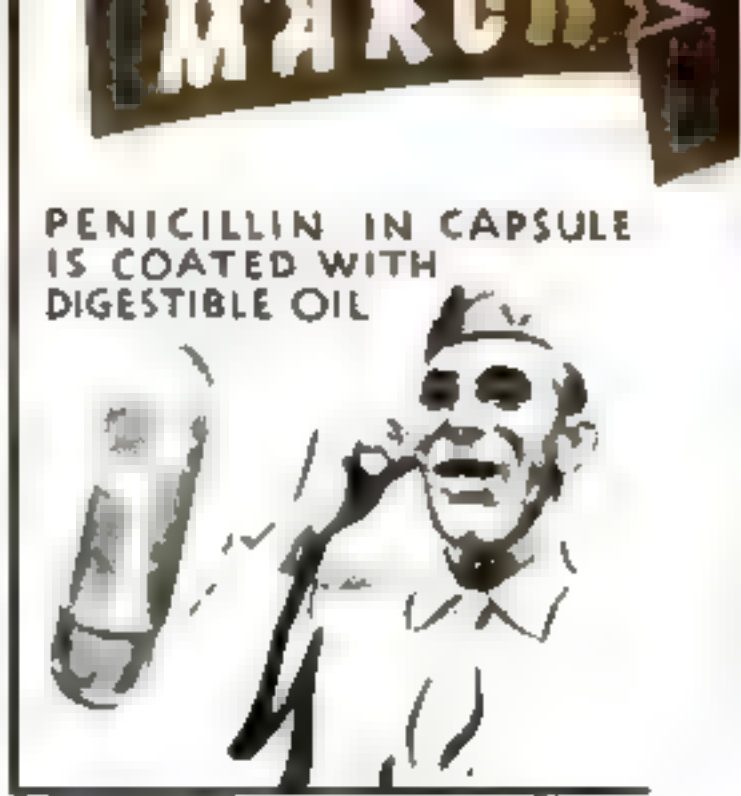




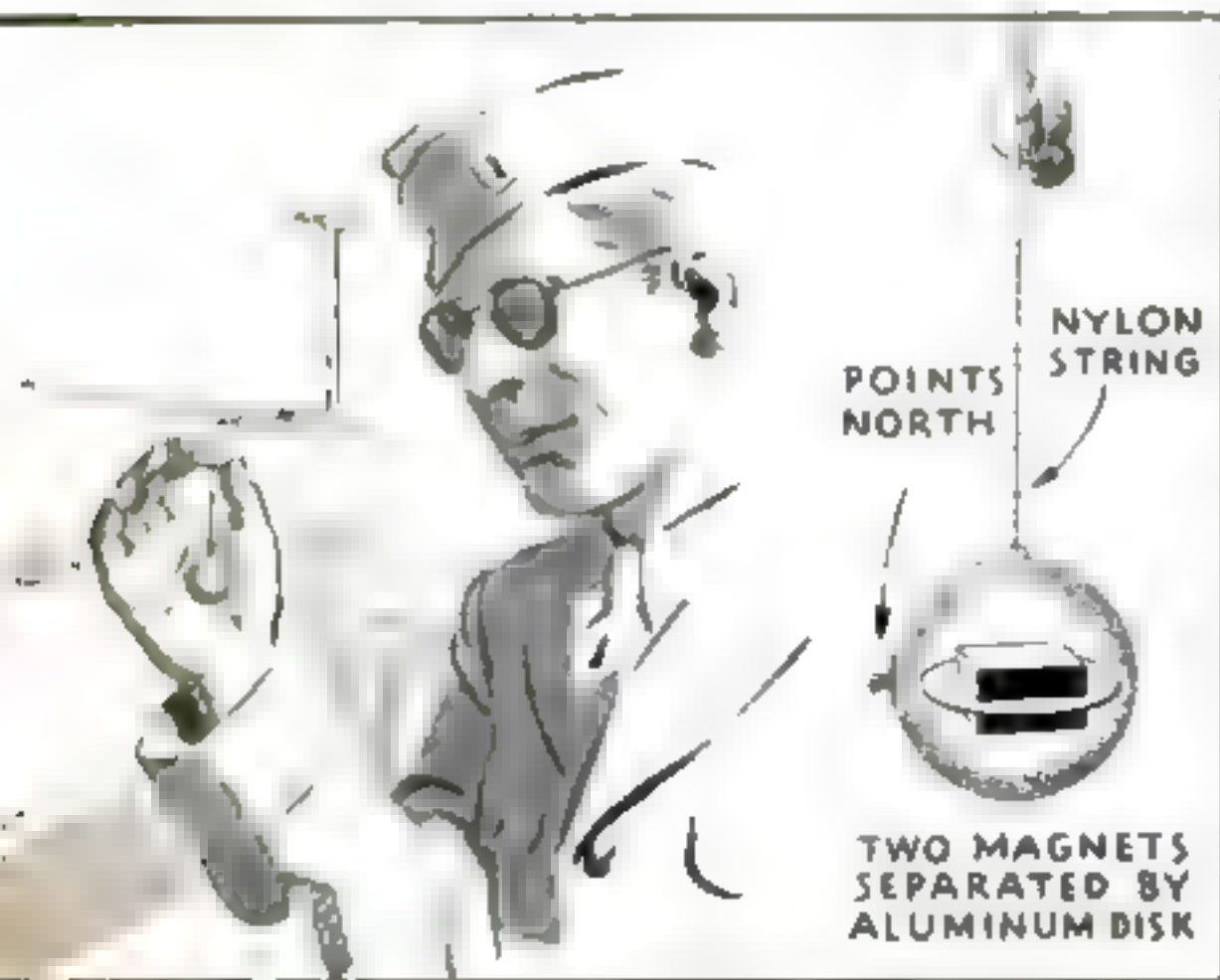
FOOT PAINS from flat feet or other causes are being treated in the armed forces by injecting procaine hydrochloride through the sole of the foot. Average hospitalization has been reduced by about 80 percent.



FAT PEOPLE, or tall ones, can't keep their balance as well as thin or short folks. Women of the same proportions are steadier than men on an unstable base. A test among about 300 men and women at Stanford University, Palo Alto, Calif., established these facts.

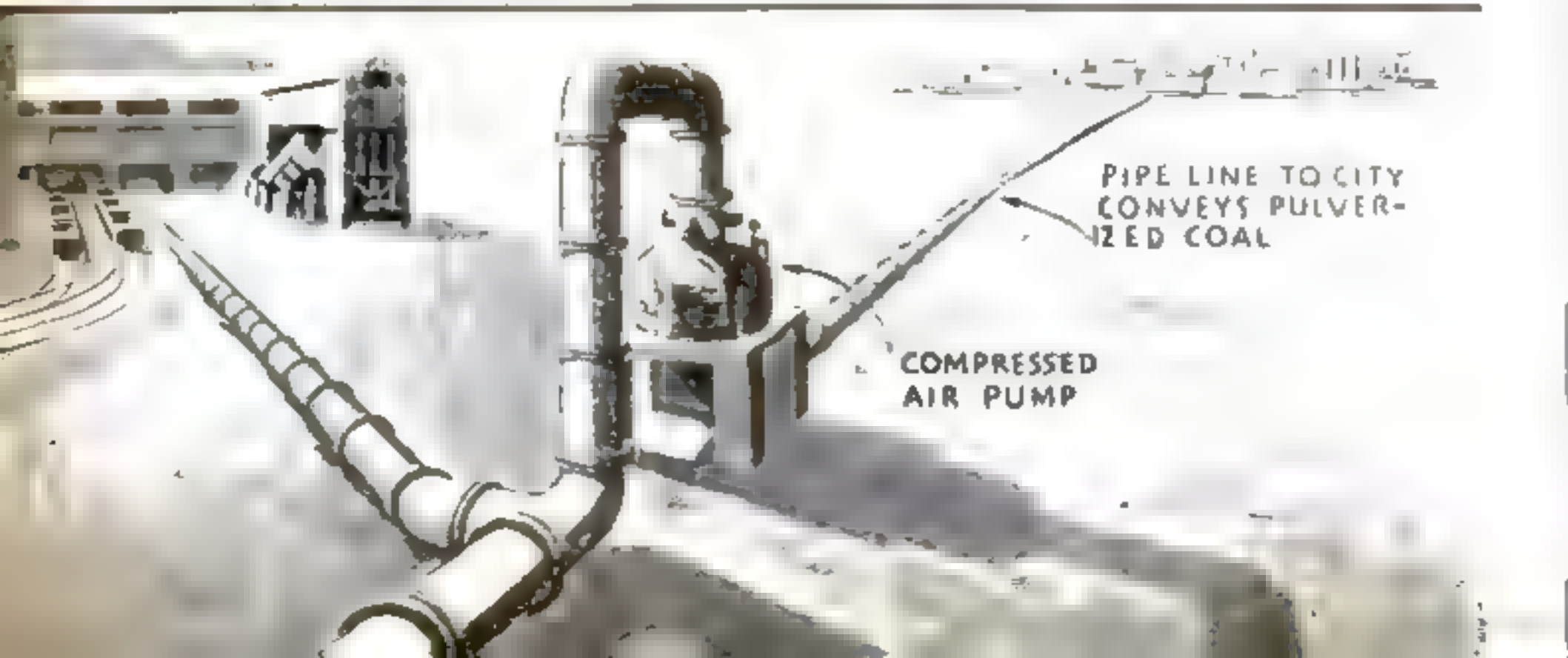


PENICILLIN can be swallowed instead of injected if it is suspended in digestible oil and enclosed in a gelatine capsule. The oil passes through the stomach into the small intestine, where it breaks up and releases the penicillin into the blood stream for assimilation.



BLIND MAN'S COMPASS, devised for sightless veterans, consists of a plastic ball holding two balanced magnets separated by an aluminum disk. The ball hangs from a nylon string, and 30 seconds are enough to steady it so the surface knob will point north. Reginald E. Beauchamp, inventor, calls it the Braille compass.

PIPE LINES FOR COAL. Propelled by air pressure, pulverized coal in suspension will be piped across country much as oil is, according to engineering forecasts issued by the Bituminous Coal Institute. The pump shown below develops 90 pounds' pressure and moves coal at 50 m.p.h. with booster pumps at intervals.



IT RAINS FISH on St. Lawrence Island in the Bering Sea. An explanation of this mystery of the arctic is offered by Otto Geist, anthropologist. The showers come in winter when heavy east winds sweep inland across the ice pack. Snow so near the temperature of the water that it does not melt, and therefore sinks, forces the fish to the surface. There they are frozen in the shelf ice. When this breaks up, the wind whips the exposed fish into the air.



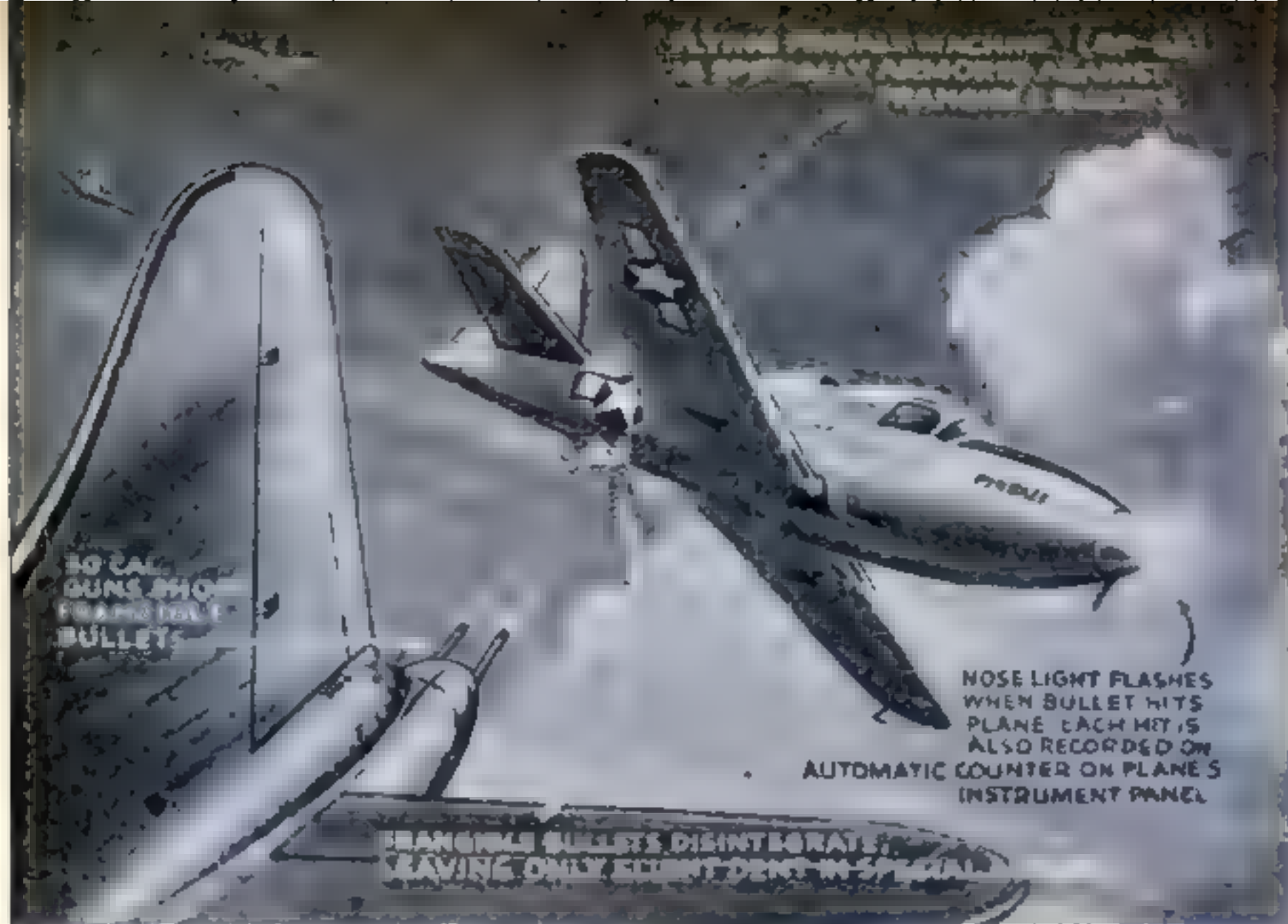
- 1 Fish are forced to surface of Bering Sea by cold snow that sinks like sand. At the top...
- 2 They are frozen fast in upper shelf ice. Pressure lifts broken ice cakes; exposed fish are freed...
- 3 And the wind blows a rain of tomcod and sculpin down on the natives of St. Lawrence Island.



HEATED RUNWAYS FOR AIRPORTS are proposed for keeping the take-off and landing strips clear of snow during the winter months. This system may prove to be a solution of one of the major problems in the operation of airports. Heretofore it has been only partially solved by plowing and carting, or rolling the snow to a hard-packed surface. The drawing below is an artist's conception of how the new system would work. Wrought-iron pipe grids cir-

culating hot water are expected to raise the surface temperature of the strips to 40 or 45 degrees, providing sufficient heat to melt falling snow and evaporate the moisture. The contrast of cleared, dry runways with surrounding snow would make landing easier for pilots. Since the system would need to function only during the time that snow is falling, it is believed that the cost of operation could be kept within reasonable bounds.



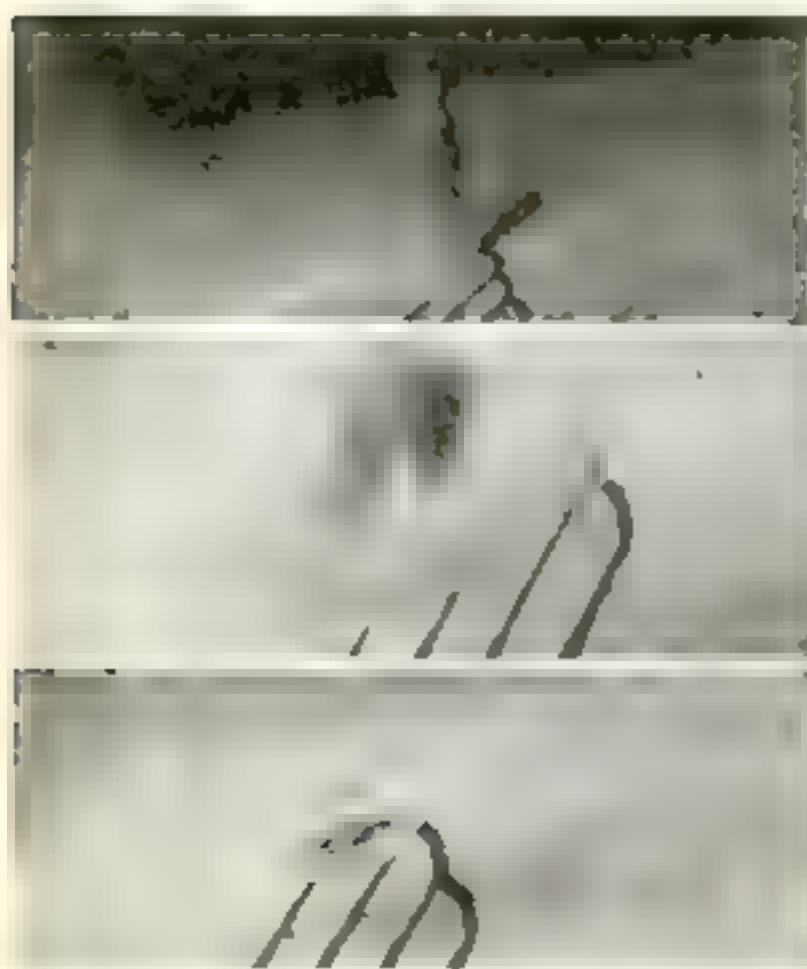


Flying Fortress guns blaze at a darting Kingcobra with live ammunition in nearest thing to real combat.

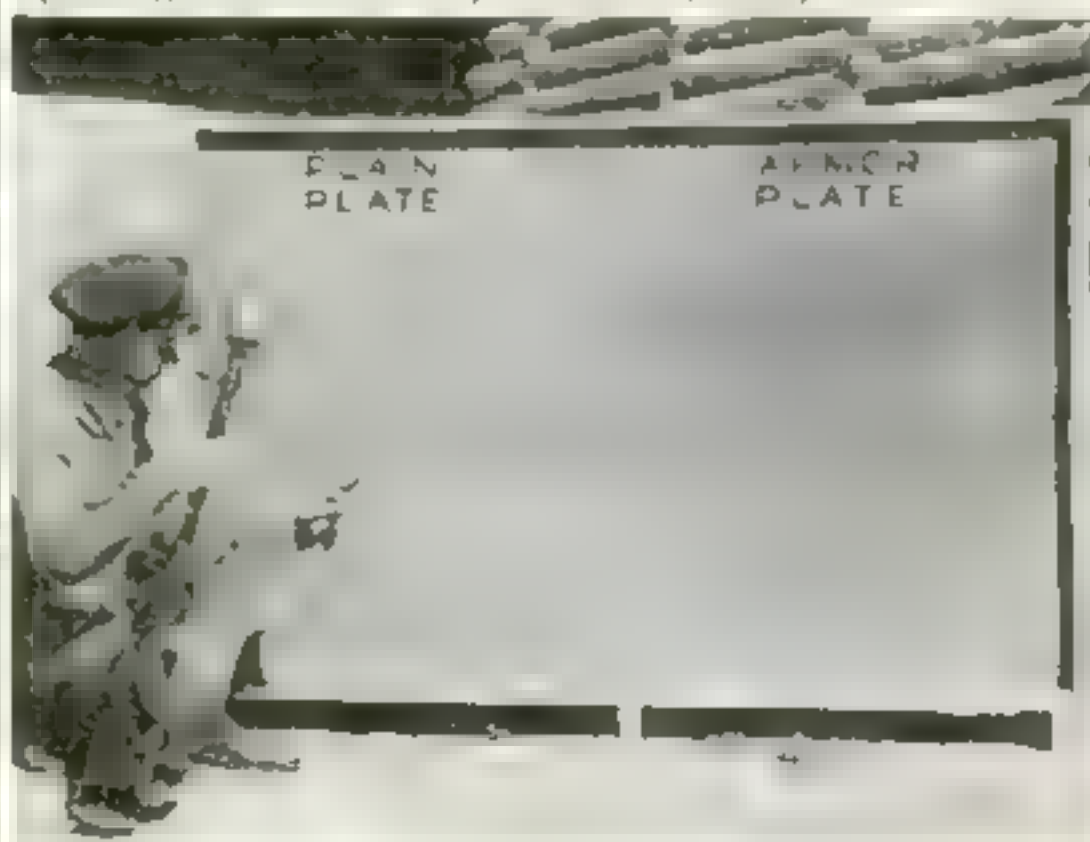
BRITTLE BULLETS GIVE AIR GUNNERS COMBAT PRACTICE

YOU mean asked Capt. Charles E. Everett, a Hismarck Sea battle veteran with a Distinguished Flying Cross, the Air Medal and the Purple Heart "you want me to fly this airplane while you shoot at me from a bomber with that machine gun—and I can't shoot back?"

"That's exactly it," said the major. Then he handed Captain Everett a rifle



Pictures at left show lead-and-plastic bullet hitting RP-53's armor, leaving but a smudge. It would pierce ordinary plate (below), but makes merely a dent in specially treated armor.



Gunner's marksmanship is instantly apparent. When he scores a hit, a light flashes in the propeller hub of RP-63 (right). Another light flashes and the hit is recorded on target's instrument panel (below).



and defied him to damage the plane that he was expected to fly. The pilot aimed carefully at its weakest spot and blazed away—without even denting it.

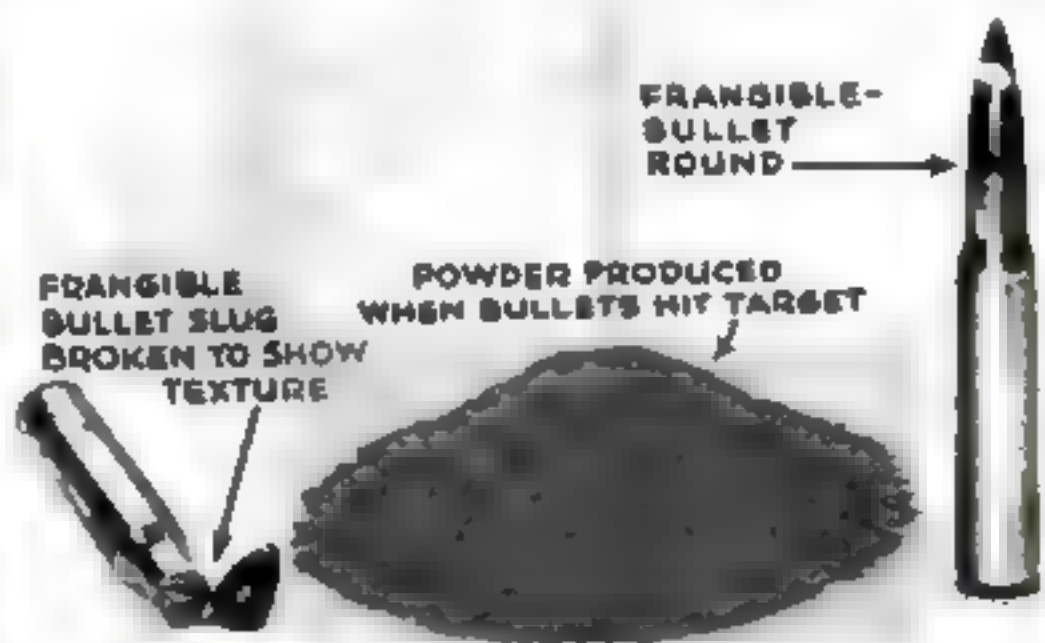
Later, when Everett dived this plane toward a bomber, the gunner who was ordered to open fire on him danced nervously and missed. So the Captain made a second pass at the bomber. The gunner steadied

himself, sent a stream of bullets directly at the make-believe attacker, and saw a light flash in the propeller hub to assure him his marksmanship was excellent.

Such realistic sham battles are now part of the curriculum at aerial-gunnery schools. Three wartime scientific triumphs made them possible: frangible bullets of lead and plastic that shatter when they strike a target they cannot pierce; special duralumin armor for the target plane; and a radiosonic hit indicator that automatically chalks up the gunner's score.

Test shows bullet merely dents the inch-thick glass used in the cockpit canopy.

Here's a breakdown of the 30-caliber slug that permits gunners to shoot live ammunition in hot aerial sham battles.



IT SCARES

HOW A STAGE



75
DIAPHRAGM

SPOT-
LIGHT

RS
CONTROL LEVER
STANDARD PAINT GUNS
SPRAY MINERAL OIL
TO SIMULATE STEAM

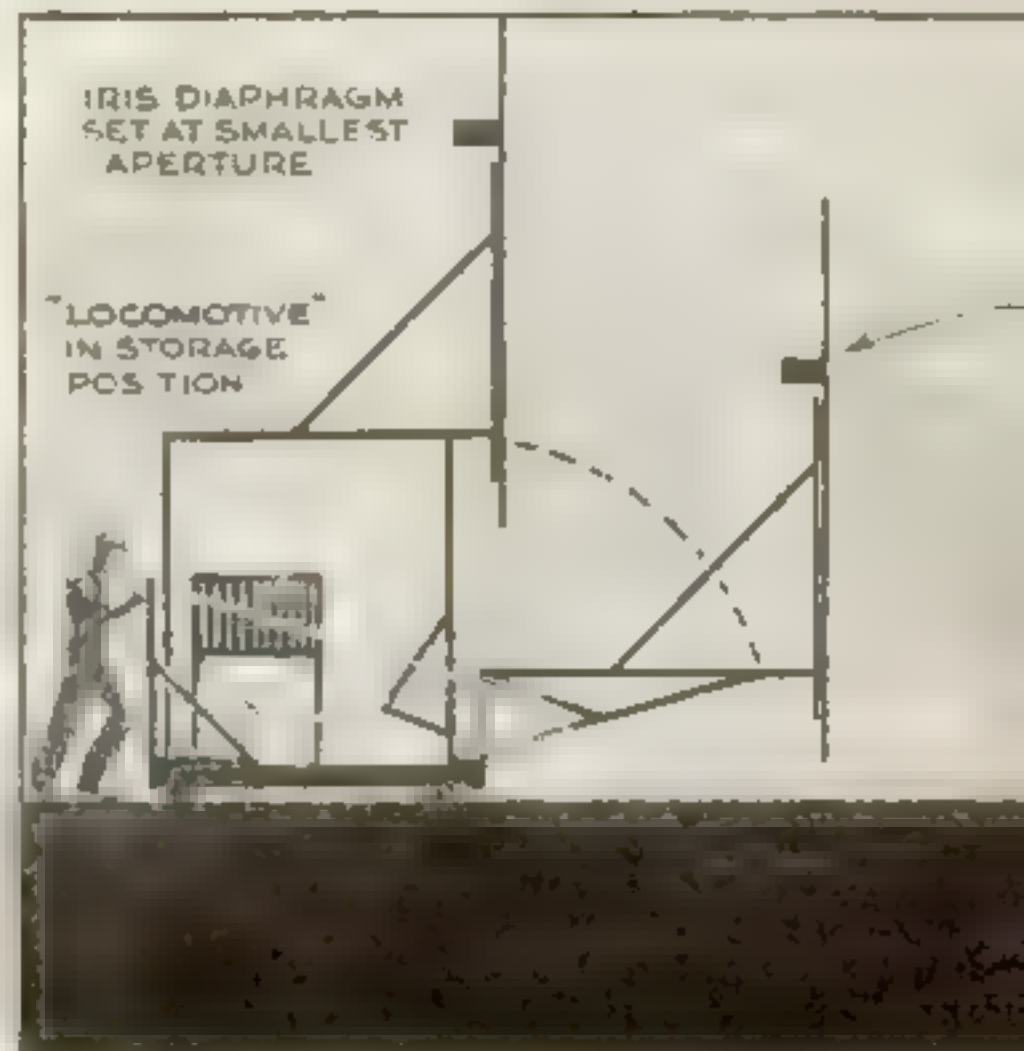
Drawings by B. G. SEIELSTAD

ROARING out of a darkened stage right into the laps of the people in the front rows, a huge "runaway locomotive" scares theatergoers out of their wits every night in the Olsen and Johnson hysteria festival "Laughing Room Only" at the Winter Garden Theater in New York.

Ingenious effects help create the terrifying illusion. The dummy locomotive front mounted on a dolly moves about 55 feet outward and downward from the back of the stage while the spotlight grows from a pinpoint of light to a blinding glare. Receding train noises blare from loudspeakers. Steam is real—sprays of mineral oil gunned into the light of a make-believe firebox. Smoke from burning coal dust billows over the spectators, mixed with particles of non-painted cork that show as sparks in ultraviolet light.

The novel "pull" comes from the special effects department of Universal Studios in California.

ANDREW B. BOONE

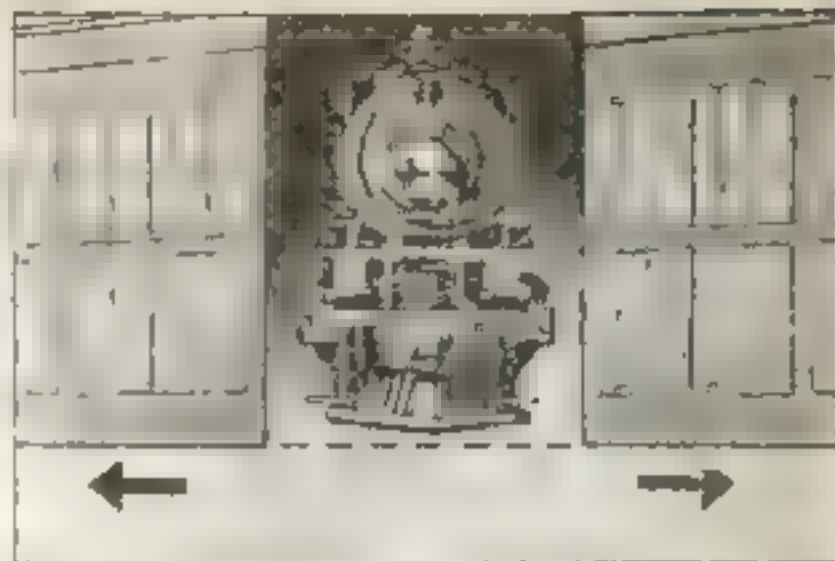


LM TO DEATH!

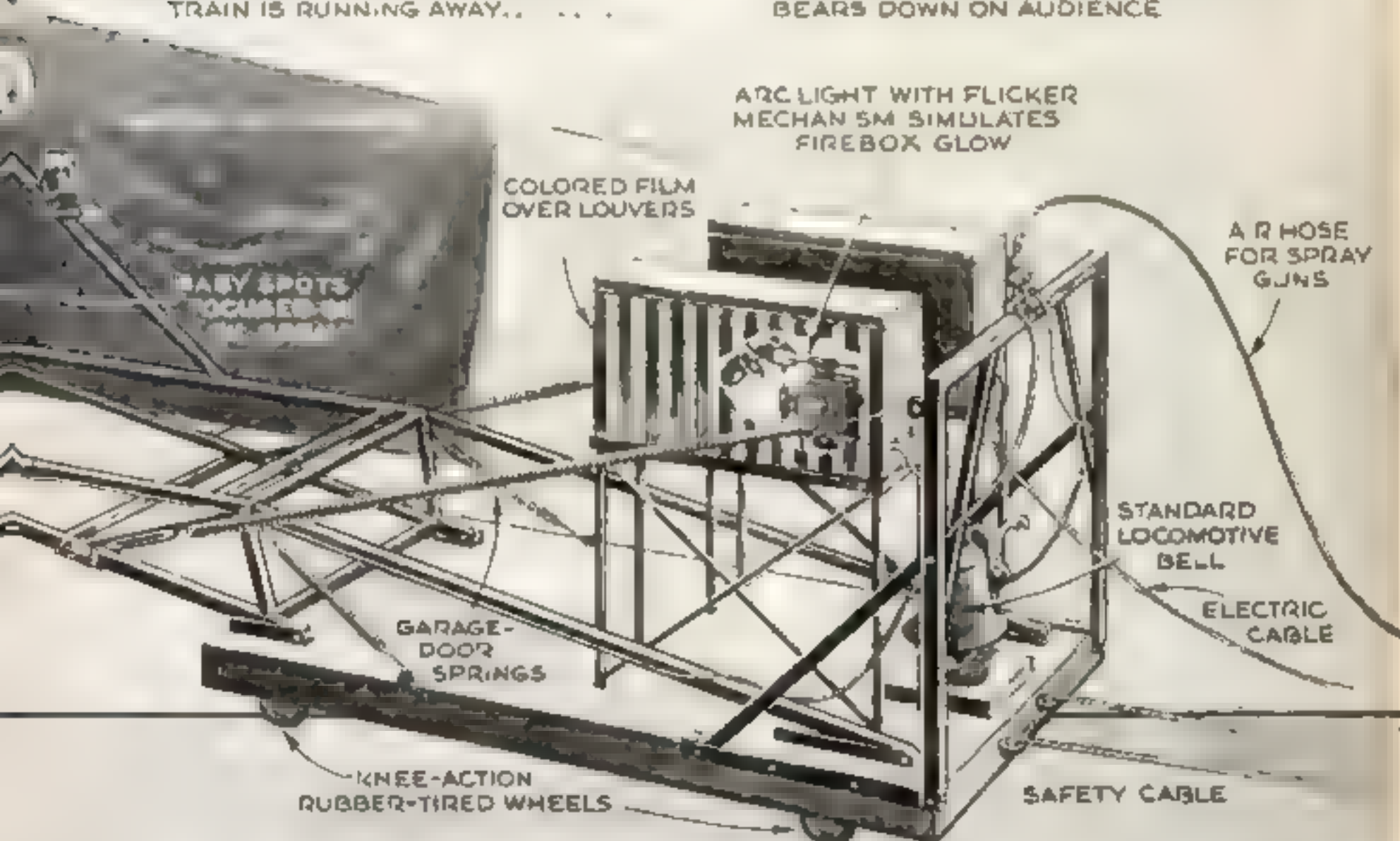
"RUNAWAY TRAIN" APPEARS TO LAND IN SPECTATORS' LAPS



PULLMAN SET, BUILT IN PERSPECTIVE, AS TRAINMEN RUSH IN TO ANNOUNCE TRAIN IS RUNNING AWAY...



THE LIGHTS GO OUT—PULLMAN SET PARTS AT CENTER—AND LOCOMOTIVE BEARS DOWN ON AUDIENCE



APERTURE OPENED GRADUALLY AS "LOCO" FRONT IS LOWERED, SIMULATES APPROACH DOWNHILL

THEN WHOLE MECHANISM IS MOVED TO APRON OF STAGE

FRONT OF "LOCO" EXTENDS OUT OVER AUDIENCE

SAFETY CABLE LIMITS TRAVEL OF LOCOMOTIVE



GENERAL MacARTHUR TOLD ME:

"This is Distinctly an Engineer's War"

We've changed the face of the earth with seven modern wonders to meet the urgent needs of air and amphibious warfare.

By MAJ. GEN. EUGENE REYBOLD

Chief of Engineers, U.S. Army

As told to VOLTA TORREY

TWO weeks before the American invasion of Saipan, we had completed new maps of the isle from aerial photos, but five months later those maps were obsolete. Two coral mountains had vanished, super-highways and pipe lines had appeared, asphalt lay where mud had been too deep for an Iowa hog, and B-29's were taking off from an airstrip longer than the longest one at New York City's LaGuardia Field. A Jap returning to bomb his former base could not believe either his eyes or his maps.

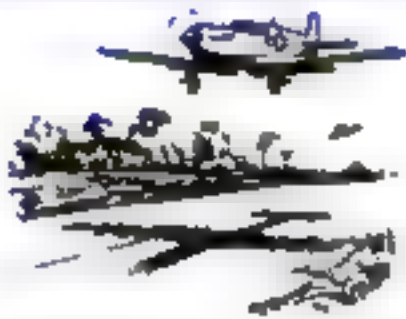
Mother Earth's face now has been lifted

this way many times. These great carpets for airmen on every continent and in every sea certainly are one of the seven wonders of the modern world. Comparable wonders are (1) the roads, (2) the bridges, (3) the ports, (4) the railroads, (5) the pipe lines, and (6) the bases which have been built with equal rapidity to enable our men to win battles simultaneously on every side of the world.

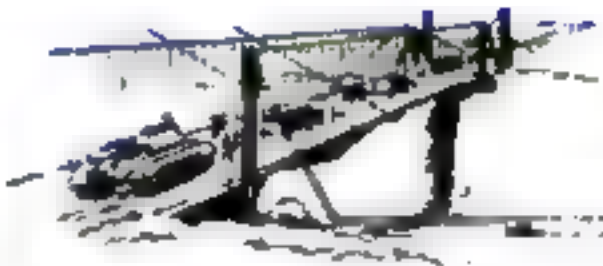
"Reybold," Gen. Douglas MacArthur told me nearly two years ago, "this is an air and amphibian war; because of the nature of air and amphibian operations, it is distinctly an Engineer's war."

Every battle begins on a map, and the Engineers literally had to remap the world for air and amphibious assaults on America's foes. For information about some Pacific islands that are well-known stepping stones to Tokyo now, we had to begin by ransacking the memories of old shipmasters and missionaries. For the invasion of France, we had to prepare 5,625 tons of maps, which is well over 200 freight-car

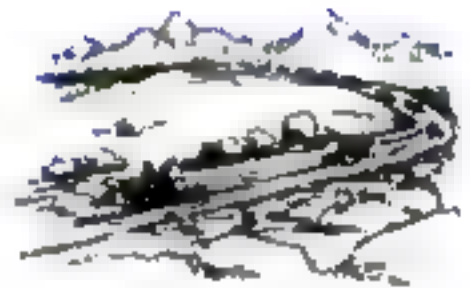
SEVEN ENGINEERING WONDERS OF THIS WAR



AIRFIELDS. Smooth carpets for planes have appeared as if by magic in all parts of the world.



BRIDGES. Never before have so many spans of so many types been needed so quickly and in so many places at the same time.



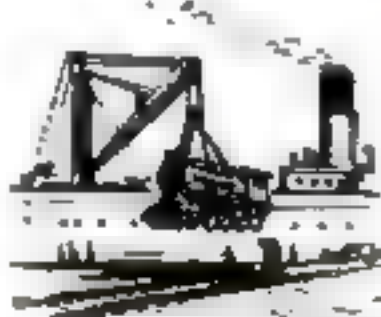
ROADS. Fleets of trucks now roll swiftly through arctic and equatorial wildernesses on war's errands.

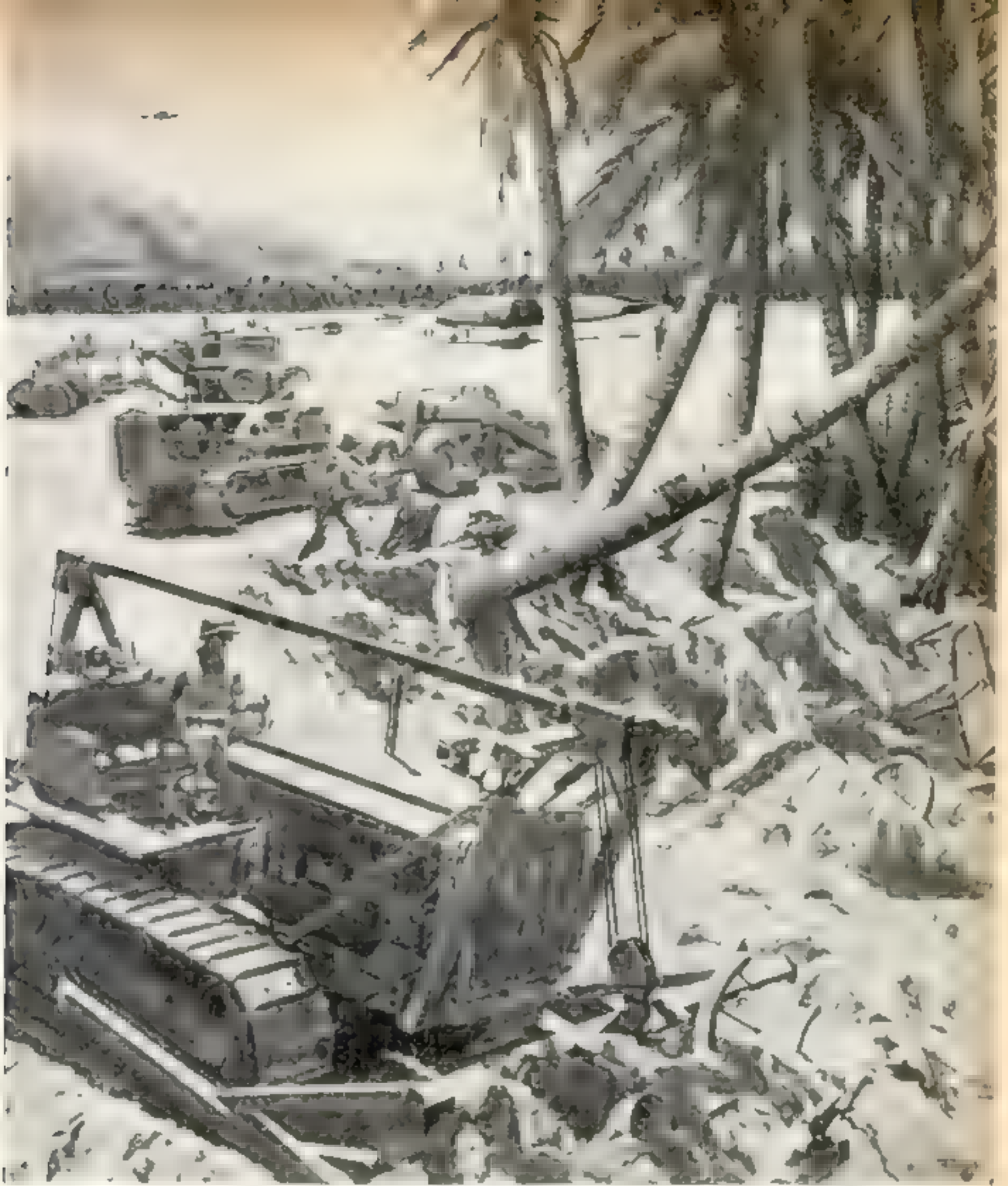
PORTS—new ones created almost overnight, old ones repaired after destruction.

RAILROADS restored in France would link up New York and Tokyo.

PIPE LINES keep up with advancing armies to supply fuel.

BASES built as fast as beachheads are taken handle 700,000 supply items.



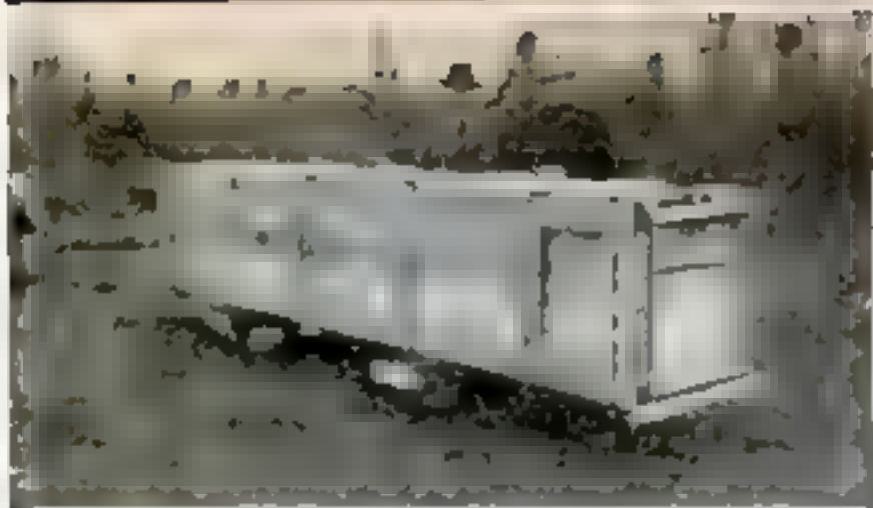


THE BULLDOZER is called the symbol of America at war. Along with the tractor, motor grader, and other earth-moving machinery, it gives us and our allies the superiority in "work-power" that wins modern wars.

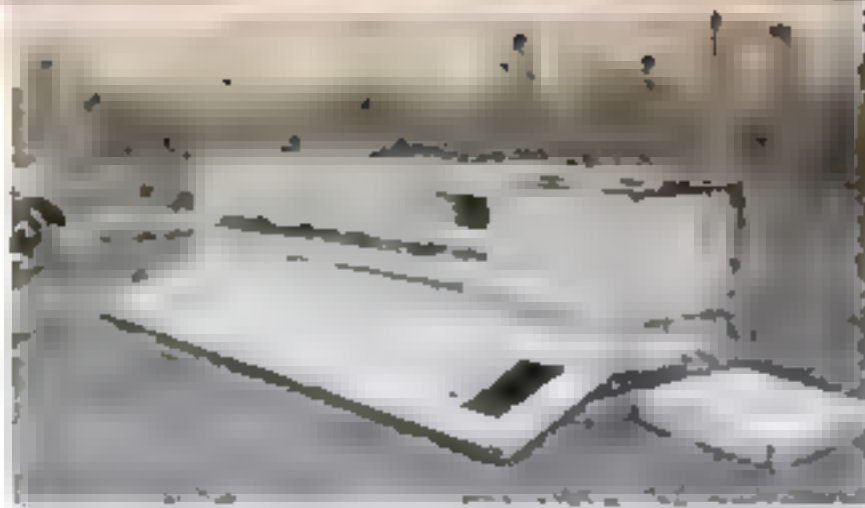
Its immediate ancestor was the Russell "Bull Dozer," or marsh filler, seen at right in a 1917 catalog drawing. Farther back it is descended from the wooden Mormon-board plow used in laying out the Union Pacific.



Drawings from Caterpillar



1 This box contains a tropical building shell big enough for 28 men. Weighing 4 500 pounds, it takes up only 100 cubic feet of shipping space.



2 Every part of the package except the end pieces is used in building the house. A hammer and a wrench are the only tools needed in putting it up.



3 Parts for the framework are laid out on the ground. Wood is soft or yellow pine, while the covering material is sheet or corrugated steel.



4 Supporting post and rafter bolted together. Note the metal cradles bolted to the frame. These will receive the ends of horizontal members.

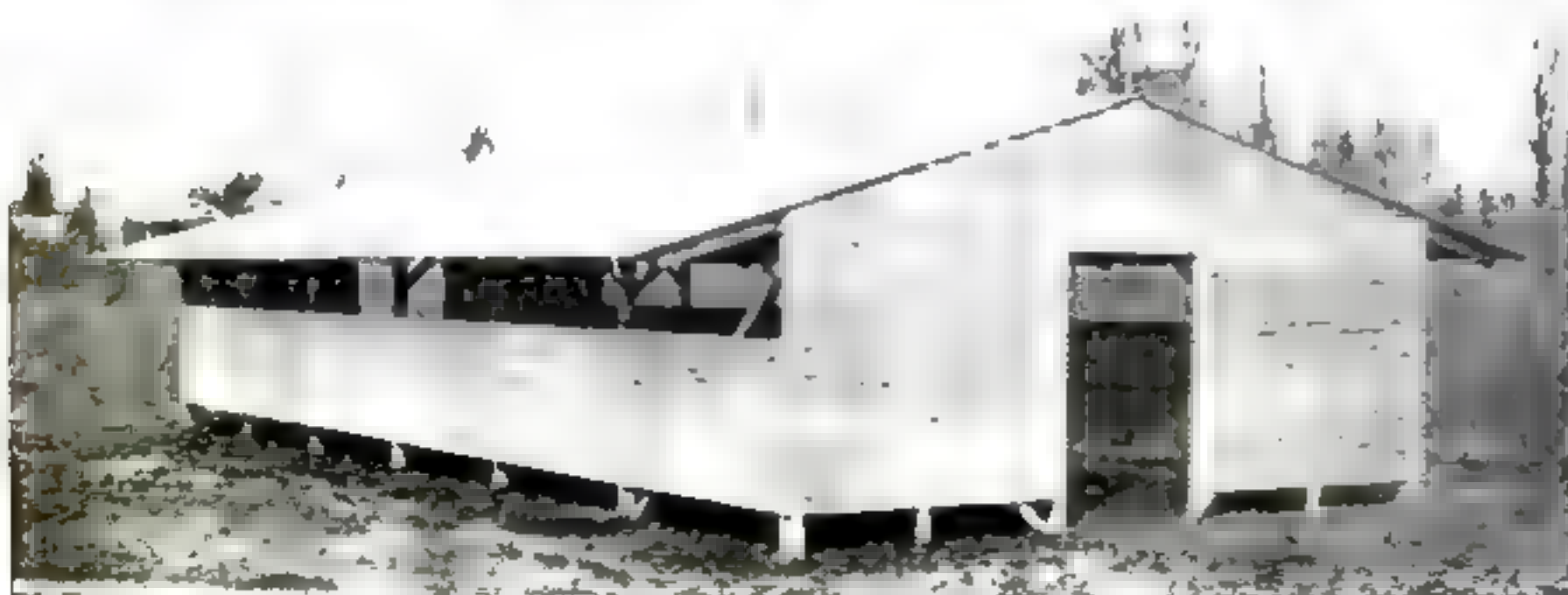


5 House-raising begins with one of the end sections as the posts are set in shallow holes. It is not necessary to level the site perfectly.



6 The building takes shape as the framework is completed. These houses are much better for the tropics than tents, which never can dry out.

7 This is the complete shell, which serves as an emergency shelter. A second kit, weighing 6,000 pounds and occupying 163 cubic feet, contains insulation, doors, screens, and other fittings for permanent use.





AIRFIELD CARPET is laid on a bombed-out Luftwaffe base by a 'stampicker' (left), which unrolls asphalt-impregnated 'hesion mat' while Marauders take off from a nearby strip. This surfacing material has helped our Engineers provide fields for tactical air forces giving close support to ground forces. The machine is reloaded in less than a minute. Sketch by Capt. Bryan de Grineau, The Illustrated London News.

loads. The 116,000,000 maps in this single order were approximately four times the total prepared and printed for all of World War I.

At the same time that these miles of paper plans were being made, however, the Engineers had to make it possible to move millions of men and billions of tons of matériel over supply lines twice as long as the equator. By June 1942, the U. S. Army Engineers were directing construction in this country at a rate of \$20,000,000 a day. If it had been possible to build the Fort Peck, Mont., dam at that pace, it would have been finished in less than a week; or the Bonneville dam in a little more than four days. But the world's biggest factories and the training camps throughout this country were but a base from which shafts had to be run to spearheads in Africa, Europe, and Asia. And these "shafts" are not mere lines on a map, but such tangible things as airfields, roads, bridges, ports, railroads, pipe lines, and more bases.

The roads include the 1,600-mile Alaska Military Highway from Dawson Creek, Canada, to Fairbanks, Alaska; the completed portions of the Pan-American Highway from Mexico to the Panama Canal; and the 1,000-mile Ledo-Burma Road from India to China. These three new roads run

PIPE LINES feed motor fuel and lubricants into every main front. Below is a valve installation at Myitkyina, Burma, on a line that gave China a transfusion. In France, Patton's thirsty tanks sucked gasoline from a line that moved almost as fast as they.





WATER POINT set up on Luzon gives Filipinos a drink. Portable purification equipment includes means for analyzing water, detecting toxic agents, and distilling salt sea water.

MAP FACTORIES in trailers enable the Engineers to provide the generals with one of the essentials of victory. Some of the maps of France produced for the invasion were captured by the Germans, who admired them so much that they had them reproduced, printed, and distributed for use by their own men.

through parts of the world where it previously was impossible to travel by truck. In France alone, Army Engineers have put into operation a road network of 4,000 miles involving the construction of 145 major highway bridges.

Nearly 700 bridges had to be strung over treacherous, snake-filled rivers for the Ledo-Burma Road. But those are only a trifling percentage of the bridges that the Engineers have built during this war.

One of the most difficult streams to span was the Volturno in Italy. It is a swift, winding river with high banks, which the Nazis held. To avoid obliteration by Nazi artillery, firing at point-blank range, our Engineers had to throw the first bridges across the Volturno in the midst of clouds of smoke generated by Chemical Warfare Service units.

On the Via Appia, the main road to Rome,



ROCK CRUSHERS are taken wherever they're needed. "Our allies and our enemies," says General Reybold, "never cease to marvel at the way we Americans can 'lay pavement like spreading toothpaste.'" In the photo at the left, a crane is filling the hopper of a rock crusher that was used in reconstructing the port of Naples, Italy, after capture.

POPULAR SCIENCE

ALL-ALUMINUM PONTON BRIDGE

is the newest thing in floating spans. Even the hollow floor boards are aluminum; if every ponton is sunk, they'll support foot troops or a loaded truck. With pontons, the bridge can carry the heaviest traffic—even a tank retriever with a tank. This M-4 bridge is intended for assault use only, for quick construction to support a bridgehead in battle.



the first ponton bridges over the Volturno had to be replaced almost immediately with a much heavier structure. The river is 10 feet deep and 360 feet wide there, and the soundings made under machine-gun fire revealed that it was both swift and full of fierce eddies. But in less than three weeks, a bridge stout enough for the heaviest trucks and tanks had been completed, and 10,000 vehicles a day were racing across it.

The spring rains washed out every other bridge over the river, but not that one.

This was but one of many demonstrations of American engineering wizardry in Italy. Things that it took Mussolini two years to build, and the Germans two minutes to destroy," an Italian commented, "were rebuilt by the Americans in two days." Even so, the eyes of Der Fuehrer's experts popped when our construction crews began to toss

MOBILE AIR COMPRESSOR

is another important Engineer weapon. The one at right is powering drills used in widening a highway in France. Besides operating many tools, it is handy for blowing up the pneumatic ponton-bridge floats and breaking up ice.





HARBORS were made to order for D-day. This drawing by Sir Muirhead Bone, official British Admiralty artist (from Illustrated London News) shows a caisson that formed a part of the famous "Mulberry" port at which 250,000 men were landed in Normany. Caissons were towed across the Channel and sunk as breakwaters.

the concrete around after their landing in France.

"My God, how can this be?" Lt. Gen. Romcke, the German commander of the Brest fortress, exclaimed when he saw the use being made of Cherbourg. "They told us Cherbourg could not be used as a port. The General Staff told us that."

The prewar harbor there had been wholly artificial. The tide rises 25 feet, and construction of a passenger port had taken more than 100 years. The Germans had completed its development as part of their reparations to the French for World War I. They knew all there was to know about Cherbourg and they did everything they could to make it impossible for us to salvage that port.

They used several trainloads of explosives to shatter the breakwaters and wharves, and sank more than 100 ships in the harbor. They blew a 200-foot gap in the main jetty. They sank the 9,000-ton whale-oil factory ship *Solgint* to block the pier where the *Normandie* had docked. They toppled

locomotives and freight cars into the inner basins, and dumped quay walls on top of them. They left the giant cranes drooping like old cornstalks, the railroad terminal a maze of twisted rails, and every known kind of mine and booby trap concealed beneath the water and amidst the wreckage. A single team of U. S. Engineers found and deactivated 24 carloads of sea mines in or near the harbor.

It took 9,000,000 board feet of lumber—enough to cover a city block, solid, to a height of more than 100 yards—and equally stupendous quantities of steel, cement, sand, and aggregate to reconstruct the port of Cherbourg.

But whereas the peak capacity of the port in peacetime had been about 2,000 tons of cargo a day, it was developed by the U. S. Engineers to handle more than 20,000 tons a day only three months after it was captured. Cherbourg was the only major port we had on the French coast to support General Patton when he started his 400-mile sweep out of the Cotentin Peninsula.

*Your
Pin Up-*

P-50 BELL AIRACOMET JET FIGHTER

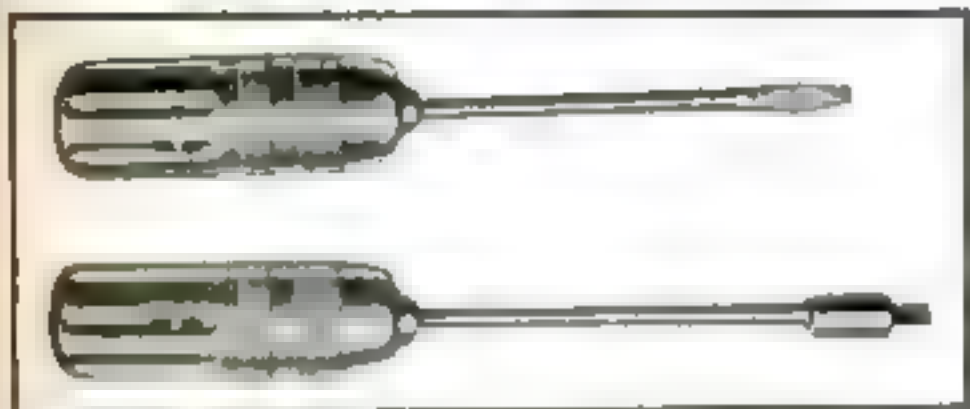
AMERICA'S first production jet-propelled plane, the Airacomet, may mark the beginning of a new era in high-speed aircraft propulsion. (See page 70.) It is driven by two General Electric turbo-jet engines. Top speed is still a military secret.



new Tools

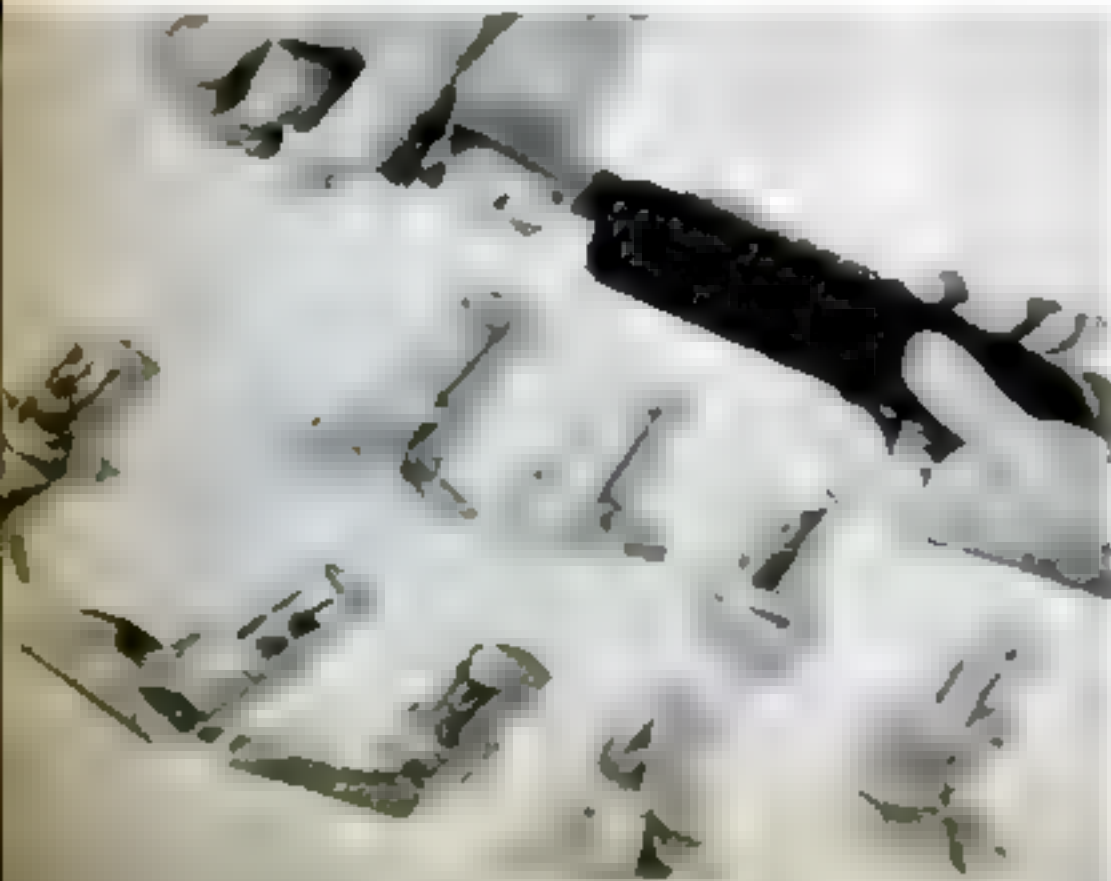


QUICK-FASTENING lock nut, made of spring steel, is now supplied by Adel Precision Products Corp., Burbank, Calif. Called Stalock, it offers a 360-degree contact with screw threads, allowing positive gripping action. When screw or bolt is tightened, spring action causes contact surfaces to be forced deeper into the thread channels. At left are some of the varieties to be had.

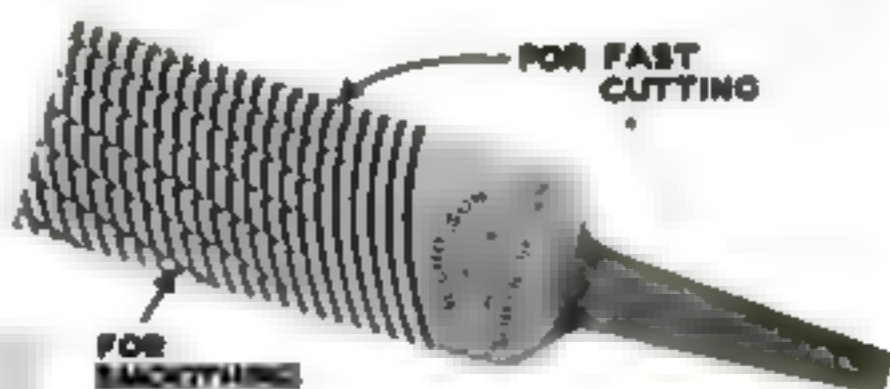


NO THREAD STRIPPING is likely if this Livermont Roto-Torq screw and bolt driver is used. The torque may be adjusted to any point between one and 25 inch pounds, and the tool disengages at the proper tension.

BETTER RIVETING, with less strain on the worker, is the object of the new bucking bar below, developed by Morris Brown, of Consolidated Vultee Aircraft Corp. Kicks from the riveting gun are passed on by the interchangeable head to a spring-operated hammer, which vibrates to kick the head back against the rivet.



A POWER HACKSAW is available through an attachment that can be easily fitted to a portable electric drill, or driven by a flexible shaft or air drill. Known as the Saw-Chief, it is made by the Chicago Precision Equipment Co.



SMOOTHS AS IT ROUGHS. Fast cutting and smooth finishing in one operation are accomplished with the newly designed Nicholson Super-Shear file. The cutting arcs are off center in relation to the axis, permitting the teeth to begin with wide gullets and a right angle for speedy and effective cutting. The teeth become shorter and closer together as they end in a long, shearing angle. Novel arrangement of teeth serves to help in clearing the file of chips.

"Mining" Oil from Dry Wells

Drawings by B. G. SEIELSTAD

THIRTY years ago, a young petroleum engineer named Leo Ranney watched oil wells peter out while geologists insisted that half the available oil was still in the ground. The trouble he knew was that a conventional vertical well tapped only a small area of the oil-bearing sand. Why, he asked, couldn't horizontal drillings be made into the sand from the oil-bearing level, to tap larger areas?

Veteran oil men shook their heads. For one thing Ranney's plan called for sinking an eight-foot shaft through hundreds of feet of rock to reach the working level. With oil gushing from the earth in competing fields, it wouldn't pay.

Wartime demands and dwindling oil reserves have changed that. An oil "mine" is now in operation in Pennsylvania, when all its 24 drillings have been "shot," it will produce as much oil per day as 3,000 vertical wells.

HOW HORIZONTAL "WELLS" ARE DRILLED

AS ONE DRILL ENTERS HORIZONTAL WELL, ANOTHER IS DRAWN FROM WELL DIAMETRICALLY OPPOSITE FOR ADDITION TO ROD

OIL IS COLLECTED IN TANK BELOW WORKING LEVEL AND FORCED TO SURFACE BY COMPRESSED AIR

EXHAUST DUCT FOR FUMES
COMPRESSED-AIR LINE

429-FT. SHAFT, 8 FT. IN DIAMETER

CLAY
SAND-STONE
SAND
ROCK
SHALE
SAND AND SHALE
OIL-BEARING SAND
CONVENTIONAL OIL WELL

OIL UNDER PRESSURE

OIL SEEPS INTO WELLS THROUGH CRACKS MADE BY "SHOOTING" DRILLED HOLES

HOW WE FIGHT JAPAN WITH

NEW INCENDIARY BOMBS PACKED WITH GEL-GAS AND
PYROGEL RAZE THE ENEMY'S FACTORIES AND SHIPYARDS

THERMITE INCENDIARY BURNS THROUGH STEEL



These three pictures show what a four-pound thermite M-54 incendiary bomb did to a sheet of steel laid across two bricks. The bomb burns for four minutes



... at a temperature of 3,400 degrees Fahrenheit. Note how molten metal drips through as the fire cuts a slot in the steel. Tough on oil tanks and arsenal roofs!

Here the bomb has burned out. Thermite has melted the steel casing, and only the hollow end part is intact.



By VOLTA TORREY

Photographs by WILLIAM W. MORRIS
and ROBERT F. SMITH

WHEN America's gel-gas incendiary bombs streak out of a B-29 flying high above a Japanese arsenal, they look just like gigantic explosive bombs. But as they plunge toward the target, these big shell-like cylinders burst open in the air, and out fly dozens of clubs, nearly as big as baseball bats.

Bright-green ribbons pop out of one end of each of these six-pound bludgeons. These ribbons, 40 inches long, reduce the rate of fall to from 225 to 250 feet per second—the speed that tests have shown to result in the most effective penetration of the roofing of typical enemy buildings. So the bombs tear through the arsenal roof more certainly than comets.

Then each bomb becomes an automatic mortar. It falls over on its side and lies quietly—until a time fuse inside its hexagonal metal case touches off an explosion. This blast shoots a sausage-shaped, cheese-cloth bullet out of one end of the bomb with enough force to throw it from 25 to 100 yards.

The sack is full of sticky, gooey, yellow jelly. As it is shot out of the bomb, the sack is split open and its contents are ignited. Gobs of flaming jelly are thus spattered over everything in the vicinity. In an attic, the fiery chunks of gel-gas are likely to be hurled into the eaves, where fires are hardest to put out. And even when a bomb falls in a street or alley, the incendiary fuel is seldom wasted, for it then is likely to be thrown on near-by walls and vehicles.

This fierce fagot, however, is only one of many types that have been developed by the U. S. Chemical Warfare Service, headed by Maj. Gen. William N. Porter, to enable American airmen to fight fire with fire.

"The best warfare," says a manual written in the Fourth Century, B.C., "is that in which charms (chemicals) are used, the next best is that in which mechanical instruments are used, and the lowest is that in which hands and hand-held weapons are used." New chemicals and new mechanisms have been brought together in new fire bombs.

FIRE -

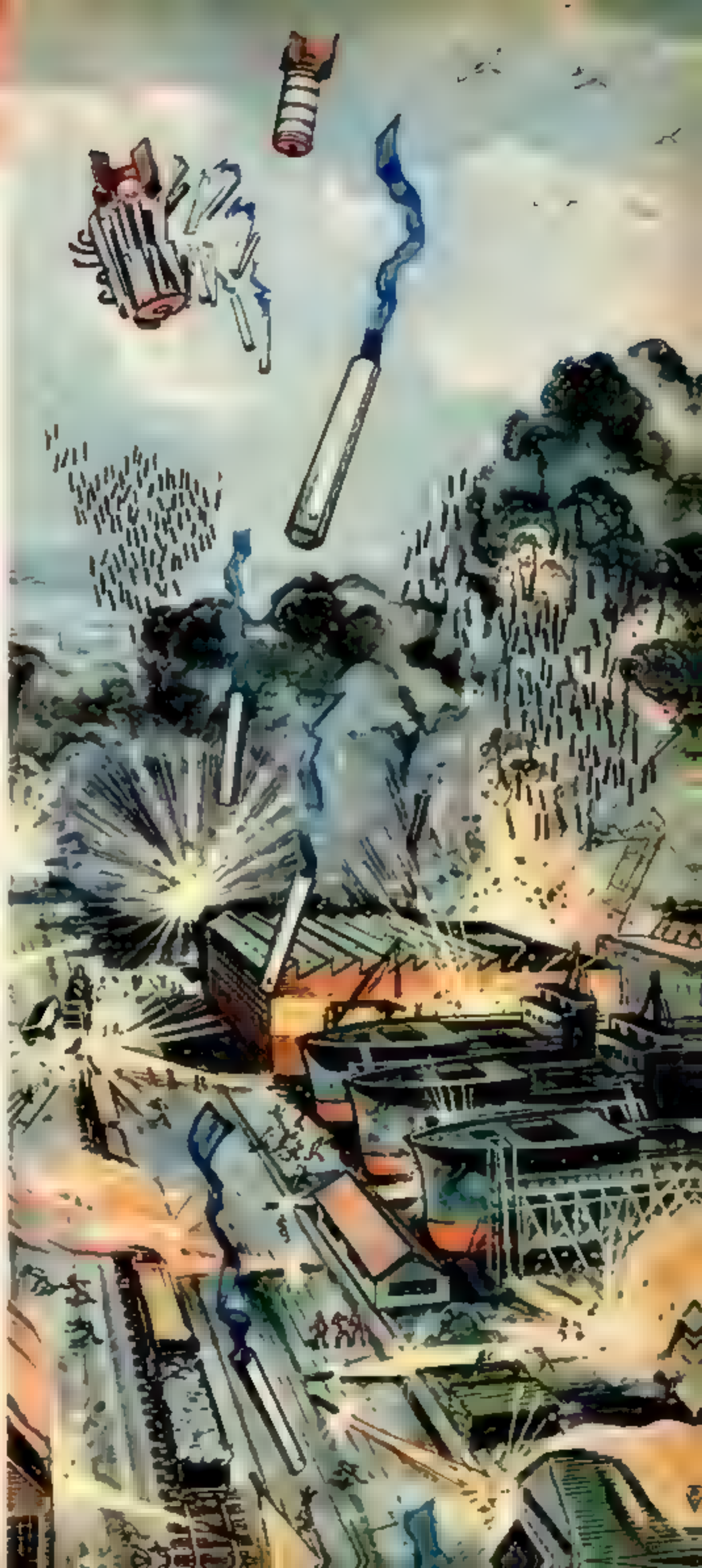
The ancient art of arson was first made aerial by America's enemies. German planes blazed a fiery path across Europe for the goose-steppers, and the Jap bomb that fell in Oregon in '42 was an incendiary. But now, thanks to the skillful use of American resources, the flames can be turned the other way.

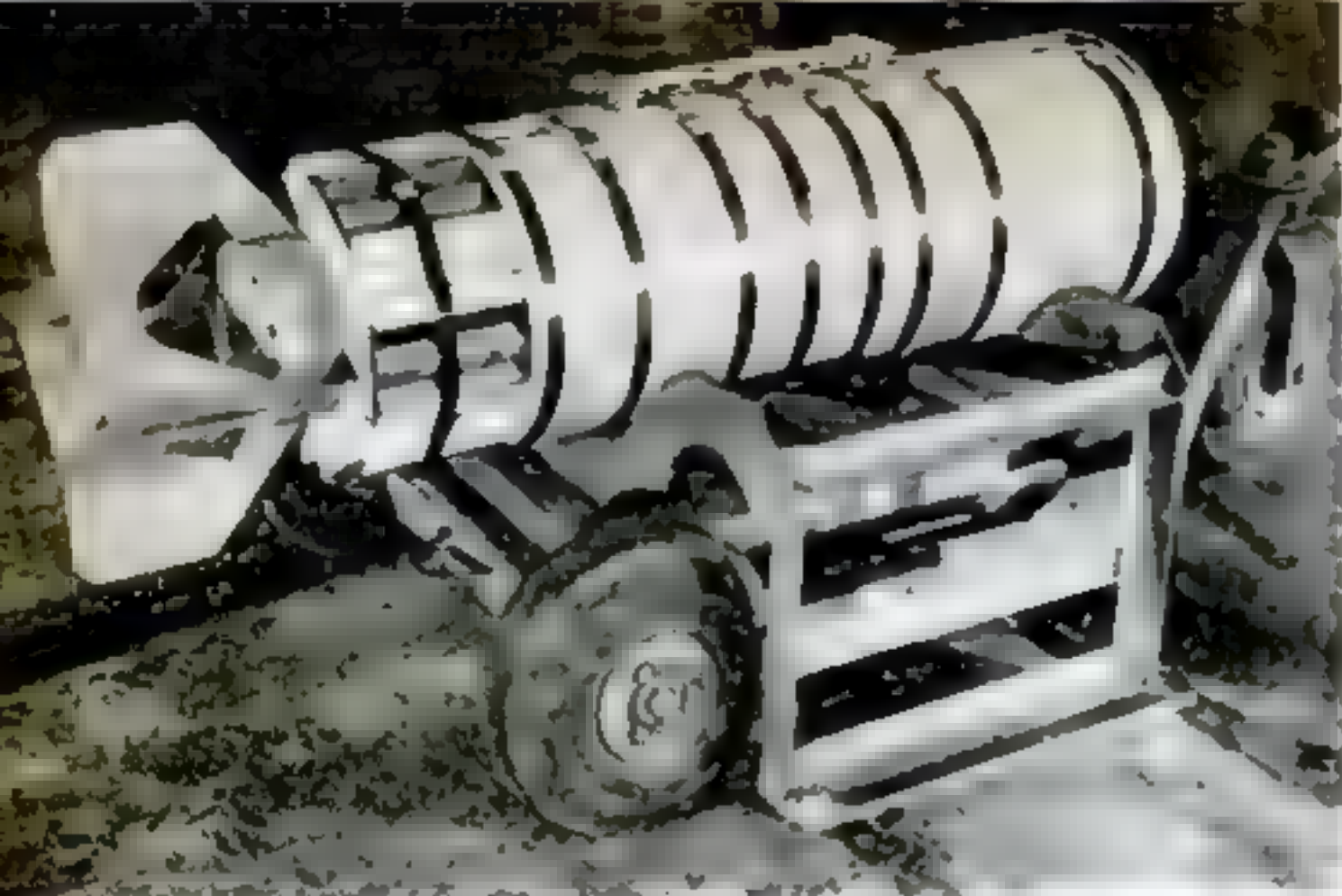
U. S. bombers at first were loaded 19 times as heavily with explosives as with incendiaries. But recent raiders have carried twice as many tons of incendiary as of explosive material. The emphasis has been reversed because flames cause more widespread and thorough damage than blasts. Factories that are merely blown apart may be quickly put together again.

America's Chemical Warfare Service, in fact, has been mainly engaged in the production of fire-spurting weapons. And its experts at Edgewood Arsenal, Maryland, commanded by Brig. Gen. Ray L. Avery, have superheated Liberty's torches to destroy the enemy's might for keeps.

The granddaddies of modern aerial incendiaries, introduced by the

Incendiaries rain on a Jap shipyard in this drawing by Eric Sloane. Big shell-like cylinders dropped by planes burst open and release dozens of club-shaped bombs. Bright-green ribbons that trail from the bombs retard their fall to best rate for penetration.





A cluster of 110 incendiary bombs on a dolly ready for loading in a bomber. The bundle will be broken open and scattered at a predetermined point after it leaves the plane for the ground

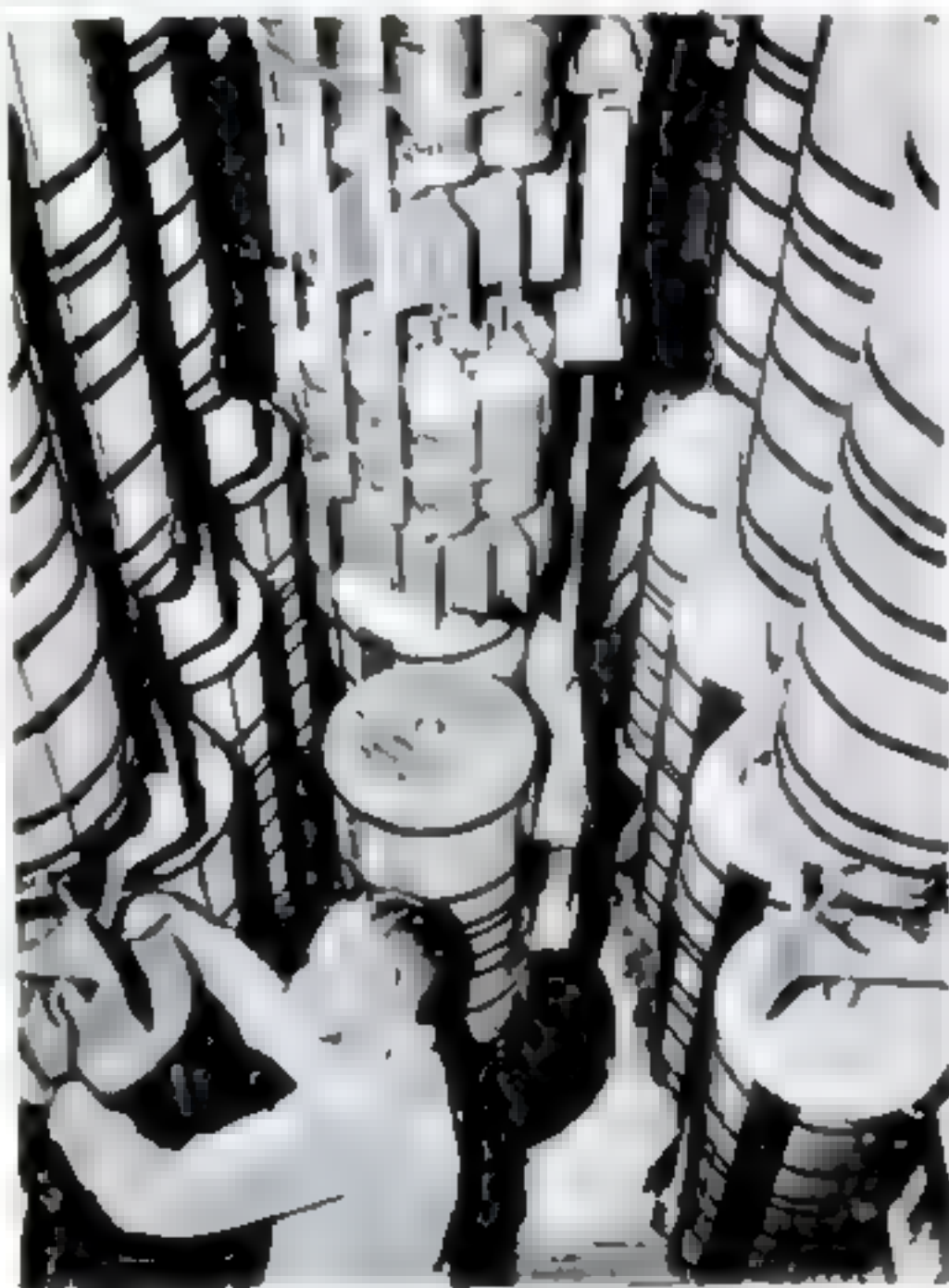
Destination Tokyo! Below, an ordnance officer of the 21st Bomber Command attaches fusing mechanism to incendiary clusters in the bomb bay of a B-29 about to take off for a raid on Japan

Germans in World War I, were about the size of footballs and contained gasoline. It burned so quickly that often it only scorched things. The Germans then developed magnesium-thermite bombs. The Axis tried these out in Ethiopia and Spain, and began the second big war with great supplies of highly developed metallic incendiaries. High explosives were hidden in some of them to rout air wardens and the effectiveness of these fireworks was speedily, amply, brutally and spectacularly demonstrated.

Experience convinced the British that the most sure-fire bombs for all kinds of attacks were those made of magnesium. But thermite, a mixture of aluminum and iron oxide, also creates terrific heat. If a thermite bomb, for instance, lands on an oil tank, it will scorch a hole in the top almost as big as the bomb, and let red-hot globules of metal drip into the interior.

The United States was drawn into the war, however, without enough of the stuff needed to make this kind of bomb. This country produced only 6,250 tons of magnesium in 1940 and needed that—and aluminum, too—to build planes. So something else had to suffice for incendiaries.

The heating capacity of materials is measured in British Thermal Units (BTU's). Each unit denotes the quantity of heat needed to raise the temperature of one pound of water one Fahrenheit degree. Magnesium has about 10,800 BTU's per pound, while crude oil has 19,500 and gasoline has 20,800. So the National Defense Research Council, including such scientists as Dr. Vannevar Bush of the Carnegie Institution, Dr. James B. Conant of Harvard,



and Dr. W. K. Lewis of Massachusetts Institute of Technology, recommended that the incendiary potentialities of petroleum be reconsidered.

This suggestion led to the creation of jellied oil, or gel-gas. It looks like mashed potatoes well soaked with butter. It is sticky, like rubber cement, and can be carried in a sack, but when this sack is ignited and split open, the gel flies out in ugly gobs

INCENDIARIES ARE DESIGNED TO DO SPECIFIC JOBS

trailing long, streaming tongues of flame.

Magnesium, however, is much denser than gasoline and is practically all radiant energy. Magnesium became available again after gel-gas had been produced. And the Technical Command of the Chemical Warfare Service, headed by Brig. Gen. William C. Kabrich at Edgewood, then decided that America ought to be armed with an incendiary having the destructive qualities of both magnesium and gel-gas.

Col. Ralph W. Hufferd and others at Edgewood insisted, in other words, on the creation of a bomb filling that would (1) spout flames like gasoline, (2) emit the intense radiant heat of a burning metal, (3) burn downward as well as upward, (4) continue to burn and flare up for a considerable time, and yet (5) be tough enough to withstand an explosion.

These rigorous requirements have been met with a new preparation that is called pyrogel. A gob of this stuff, when dropped on the floor, looks like a child's mud pie. It is heavy, gray, and doughy. Much to the annoyance of officers responsible for its concoction, it is sometimes referred to as "goop." That is a slang term used in laboratories to describe any miscellaneous, sticky mass. Pyrogel is sticky, but far from miscellaneous.

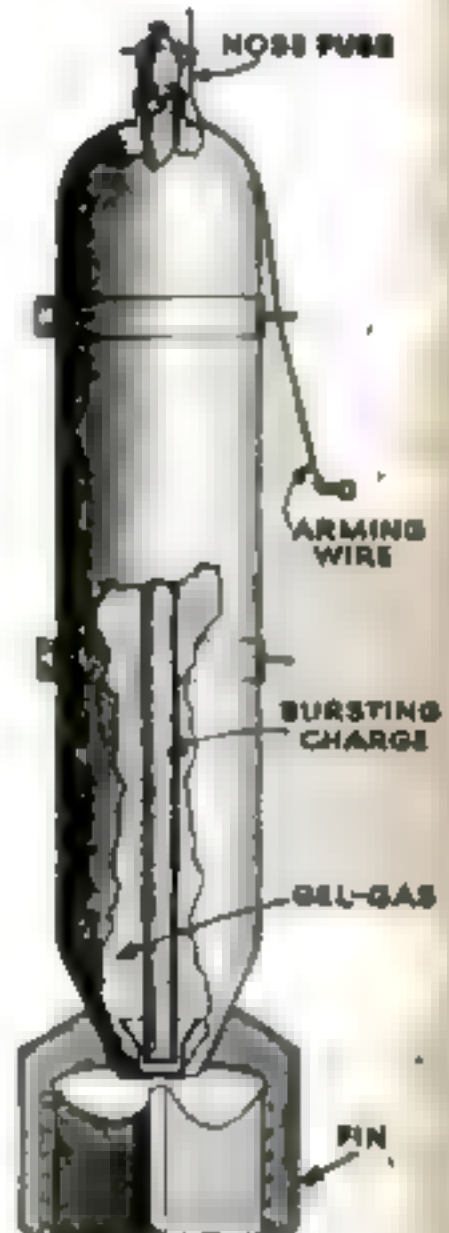
It is, in fact, a very carefully and scientifically planned pudding containing magnesium, gel-gas, and other things. Like radio performers who provide their own applause, pyrogel (*Continued on page 106*)



500-POUND "block-burner" (M-76) packed with pyrogel, a mixture of jellied oil, magnesium, and other chemicals.

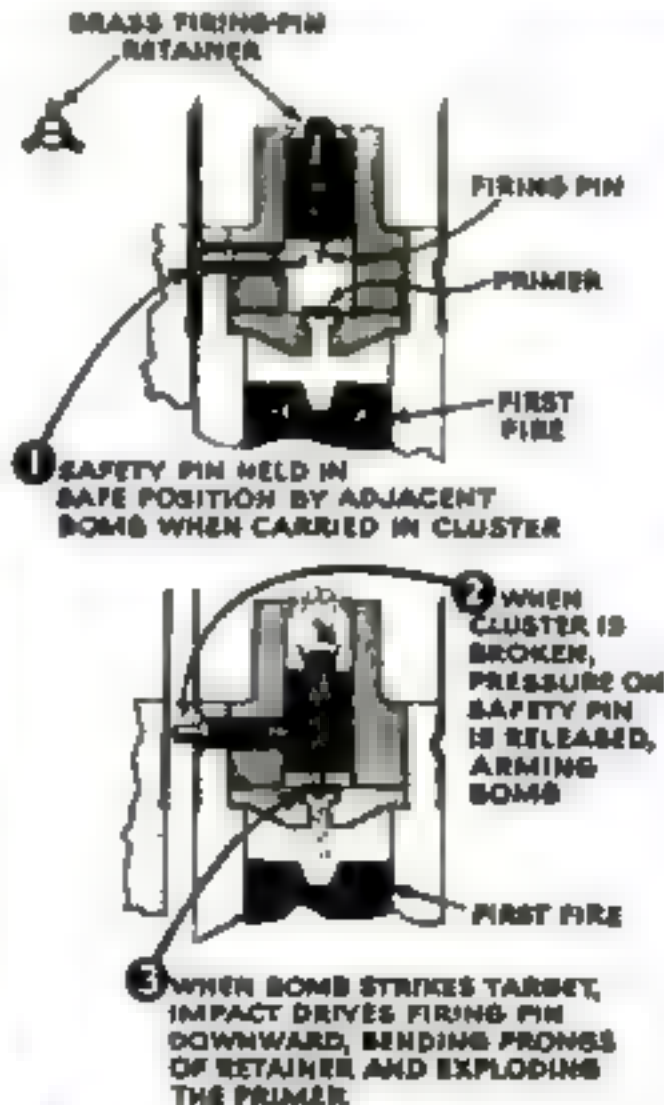
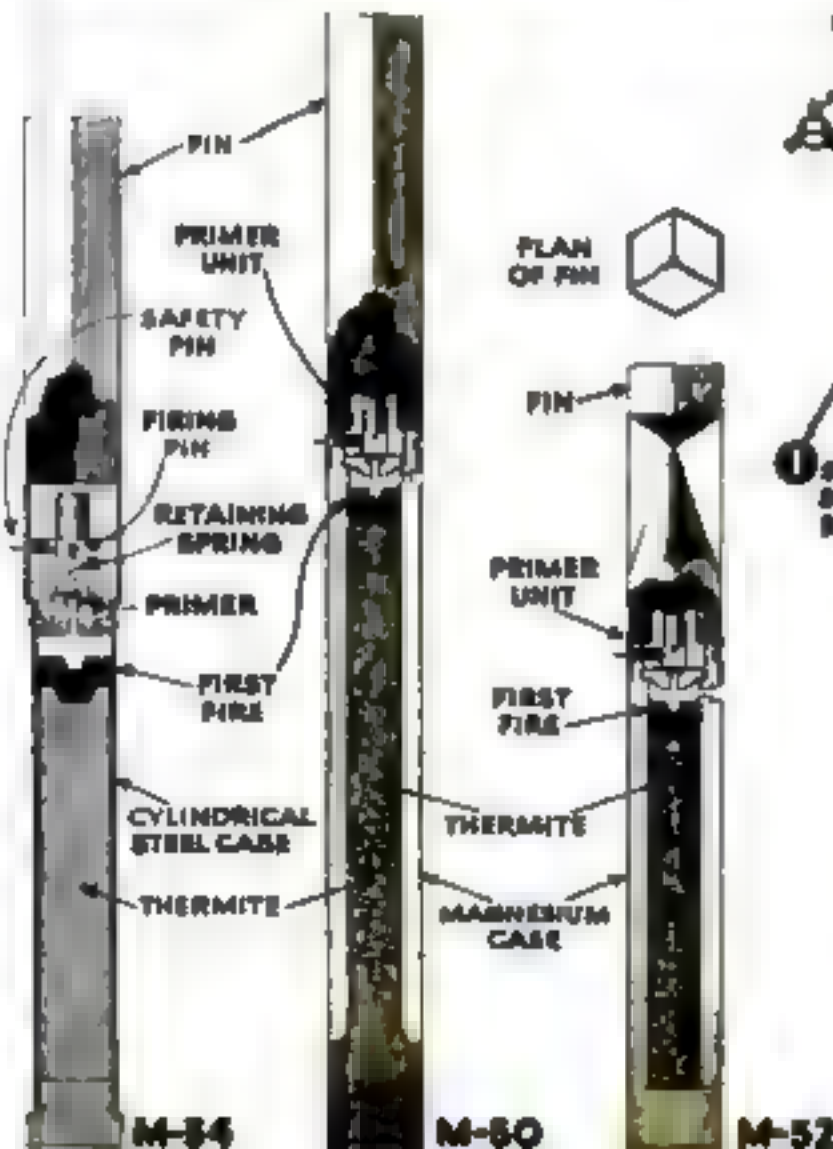


FOUR-POUND M-54 contains nearly two pounds of thermite in a hollow steel shell.



100-POUND M-47A2 jellied-oil bomb scatters its flaming, goopy filling all over an area 40 yards in diameter.

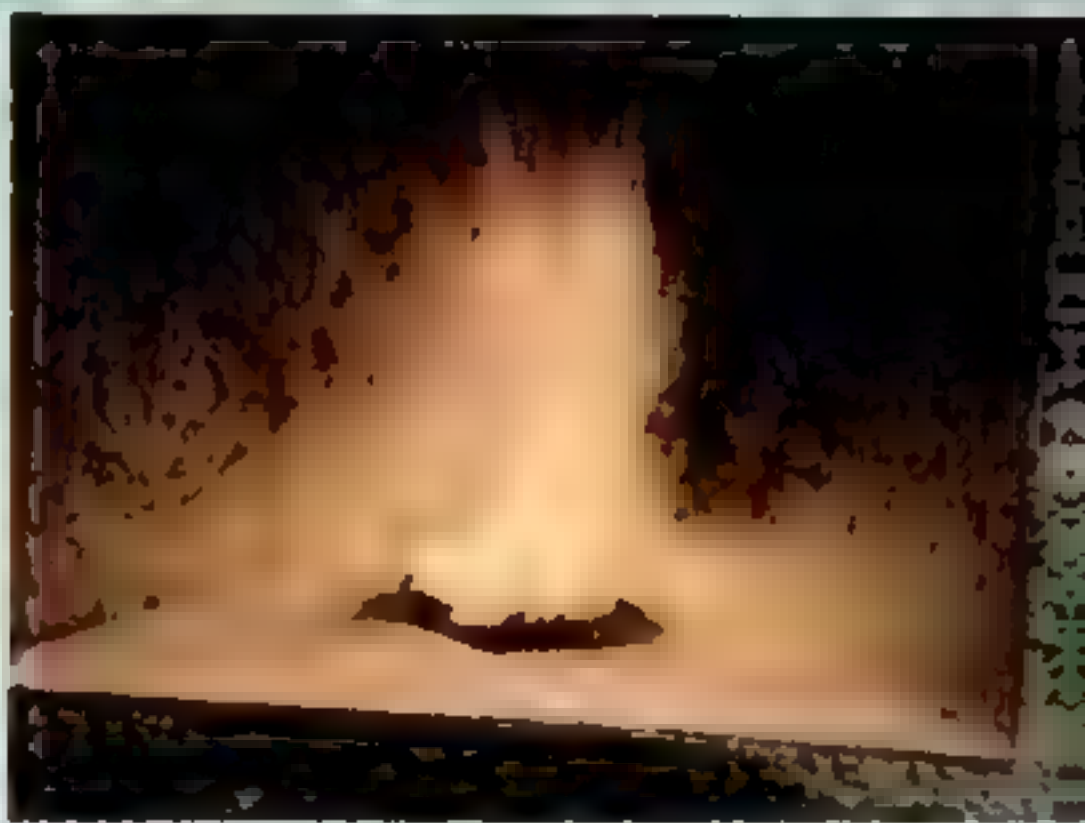
Below are details for three of our small incendiaries. Left to right: Four-pound M-54 thermite; four-pound M-50 magnesium; two-pound M-52 magnesium. M-54 is the bomb seen in action in the pictures on page 100. M-50 and M-52 are similar in construction except that the former has an iron nose. All are dropped in clusters.





M-69 IS FILLED WITH JELLIED GASOLINE

This six-pound incendiary is 19½ inches long and 2⅞ in diameter. The ribbons that stream from its tail after release are 40 inches long and are dyed green to prevent mildewing. On impact, the bomb hurls a sock of flaming jellied oil out of its tail. At any time up to nine minutes later, another explosion throws steel fragments. Its hexagonal shape makes it fit clusters.



1 To show how gel gas works, seven fluid ounces were placed in a corner of a framework of half-inch plywood and then touched off with a match.

2 Just one minute later, the flames are leaping up against the side walls. Gel-gas is a yellowish mess that looks like well-buttered mashed potatoes.

3 After six minutes, the walls are flaming well. These photographs and those of a similar test on the opposite page, were made outdoors in a rain.

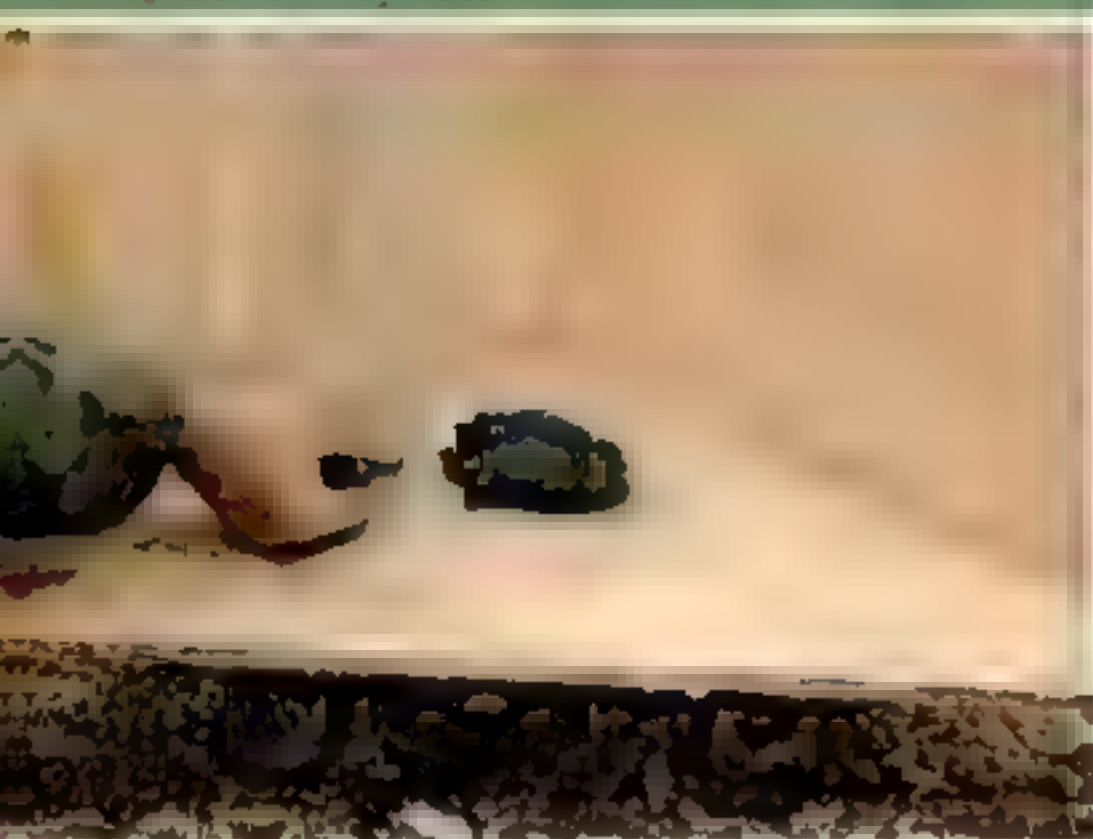
4 Fifteen minutes after the fire was started, the corner of the plywood framework has been burned completely away and the flooring charred.





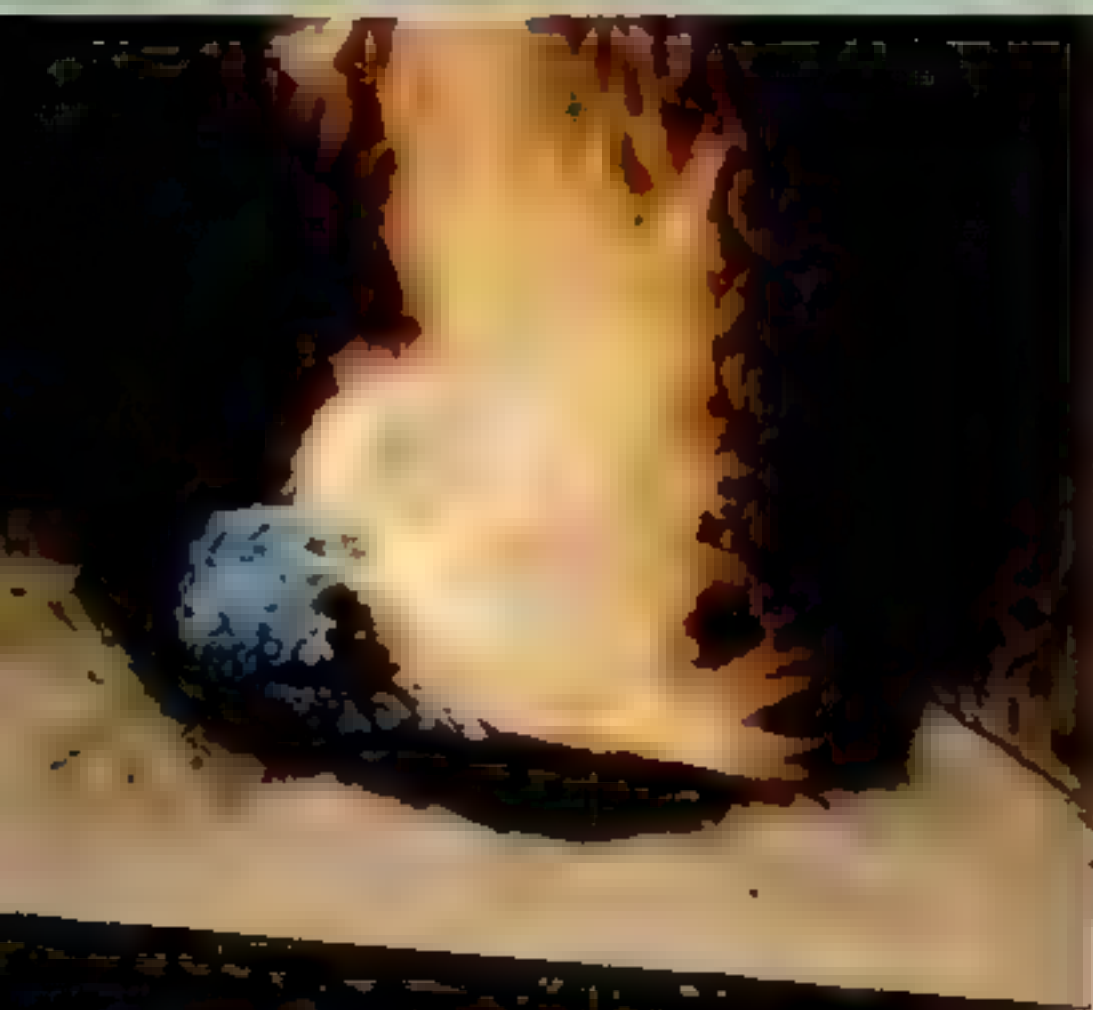
M-74 CONTAINS "PYROGEL"

This bomb is about the same size as the M-69 on the opposite page, but needs no sack to hold its filling of pyrogel. The metal rim protruding from the tail contains fins. At the other end, under a dome-shaped piece of metal, is an "all-ways" fuse that goes off when hit at any angle. Dome is blown out like a bullet by the explosion, shooting pyrogel ahead of it.



1 This test burning of pyrogel was made under the same conditions as the one with gel-gas. Pyrogel is heavier than the same volume of gel-gas.

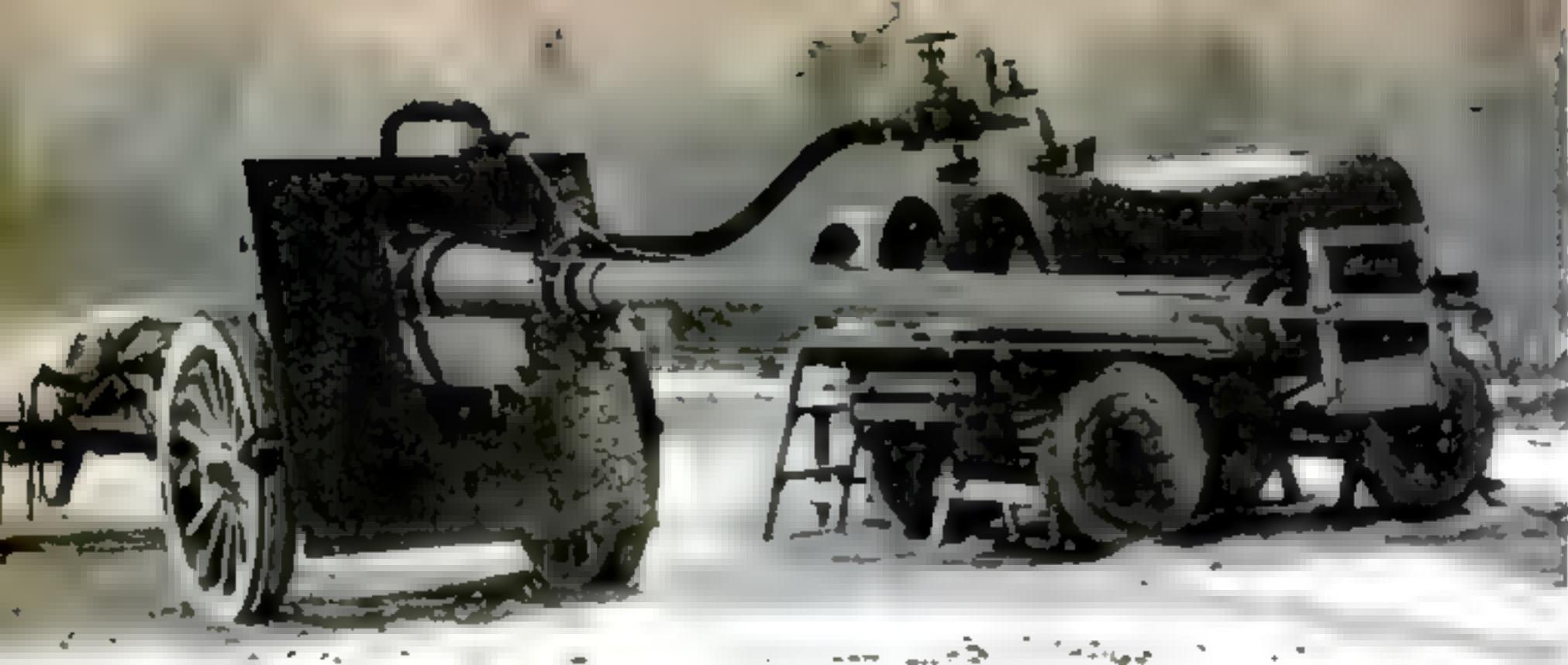
3 After six minutes, however, the ash has swelled up to several times the original volume of fuel. Any disturbance of the ash makes it flare brightly.



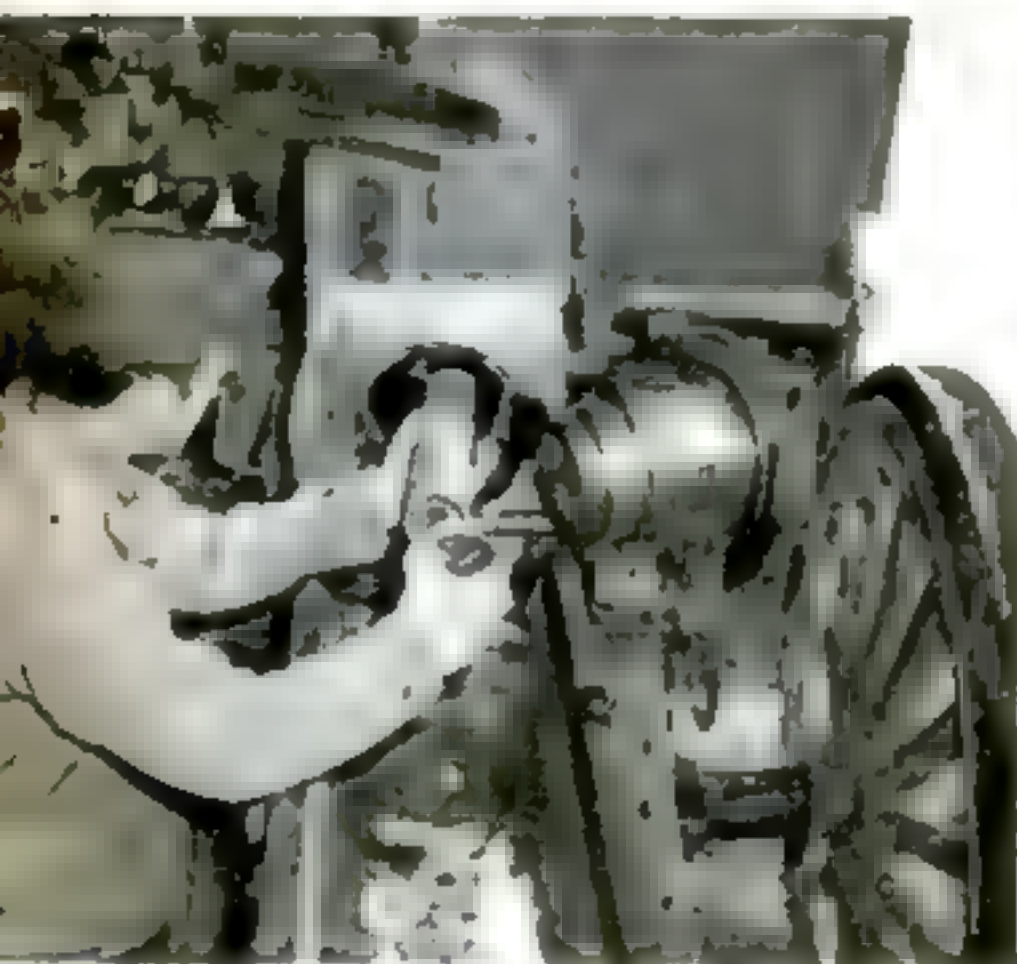
2 One minute after it was touched off, the pyrogel is flaming up the wall. So far, its action is not noticeably different from gel-gas.

4 At the end of 15 minutes, not only is the corner burned away, but a hole has been made in the floor, allowing hot coals to drop through it.

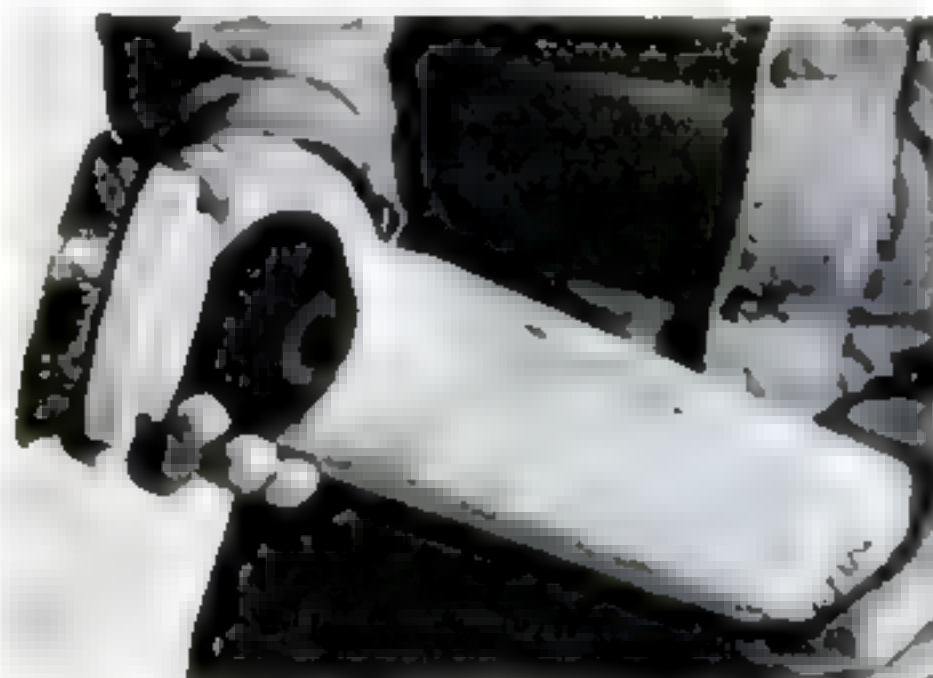




"AIR GUN" TESTS INCENDIARIES at Edgewood Arsenal. Compressed air piped from tanks into the breech of this World War I 165-mm. gun hurls bombs to simulate their falling speeds on targets.



LOADING. A small block of wood with a leather washer is placed in the rear end of the bomb when it is to be fired from the air gun. Fitting the barrel snugly, the washer keeps air from escaping around the projectile. At left, an M-74 incendiary is being loaded into the opened breech of the gun.



supplies itself with oxygen. A pound of this stuff, furthermore, takes up only about two thirds as much space as a pound of gel-gas.

Its viciousness is easier to demonstrate than to explain. If a few ounces of jellied gasoline are placed in a corner and ignited, flames leap up quickly and set fire to the walls. The same volume of pyrogel, in the same kind of corner, will not only ignite the walls but also rapidly set fire to the floor. The ash left by the pyrogel will be several times the original volume of the material and will burst into flame again when it falls through the hole burned in the floor or is disturbed in any other way.

If pyrogel is doused with water, it snatches more oxygen from the water and burns more furiously. Chemical officers do not know of any way to extinguish it. The enemies against whom it is hurled may try

to move it away from combustible materials, but explosives as well as incendiary fuel are packed into some pyrogel bombs. So the firemen must risk being blown to bits, or just wait until the mixture has burned out, then try to quench the inferno it has left.

The development of gel-gas and pyrogel, however, is only part of the story. The mechanisms invented to concentrate the flames from these fuels on combustible materials are also something to keep Japs awake nights. Gel-gas is put in tubes from which it is ejected explosively after being dropped through a roof. And when such firepots were hurled at the Japanese-occupied city of Changsha, China, the result was a conflagration that was visible for 80 miles.

For pyrogel, another type of miniature volcano has been invented. No sack is placed



MUZZLE VELOCITY is measured by the projectile breaking a wire stretched between two rods sticking out from the muzzle then another near the target. Time is recorded on tape on a phonograph turntable at right. The switch releases the compressed air



around the fuel in the bomb cylinder, and the missile's descent is controlled by metal fins rather than by ribbon streamers. Below the pyrogel there is a charge of white phosphorus, a chemical that ignites when exposed to air and stings whatever it hits. When the bomb strikes, this white phosphorus shoots out of the tail with the pyrogel, ignites it, and blankets the area with dense smoke

The fuse in this bomb is described by a conservative former professor of chemistry as "super-instantaneous." It is an all-ways fuse, which means that it goes off regardless of the angle or direction from which the bomb hits its target. It includes a striking pin enclosed in a tiny oval compartment so designed that a jolt from any direction hurls the pin against a percussion cap. The timing of the explosion that hurls out the incendiary

WHAM! This is what the M-74 bomb does to the concrete block used in the target. Air pressure of 250 to 300 pounds to the square inch gives any muzzle velocity wanted.



TARGET is a thick concrete block held in a framework. Samples of various kinds of roofing can be substituted to test penetration. The rear wall of the test chamber is heavy concrete



pyrogel is so controlled, however, that the bomb penetrates its target before sending out a shower of flaming chemicals.

Both the gel-gas and the pyrogel bombs are hexagonal-shaped pipes which can be packed tightly into round clusters and aimed with the bombsight in a plane. From three to 16 dozen incendiaries, depending on the size and type, constitute a cluster, held together by iron bands. And when thus bound into a bundle, a safety pin on one side of each bomb prevents it from going off prematurely.

These pins pop out when the cluster comes apart during its descent. The cluster is split open then by a rope of primacord attached to a separate time fuse. This fuse can be set so that the cluster will split open at any desired altitude. Thus, a plane flying at a height of 20,000 feet may drop a cluster of fagots that do not begin to scatter until they are only 5,000 feet or so above the target.

The use of these precisely controlled clusters permits airmen to concentrate their fiery hailstorms on worth-while targets. Sometimes, however, one big bomb can do more harm than scores of little bombs. So the Chemical Warfare Service supplies the raiders not only with bundles of two-, four-



FIREWORKS. This striking picture gives you an idea what happens when a 500-pound pyrogel bomb goes off. Incendiary material is hurled 200 feet in the air and scattered 200 feet away in all directions. This quarter-ton block burner has given the enemy's fire fighters plenty of headaches in recent weeks.





↑ **PENDULUM** is another device used at Edgewood in testing incendiaries. As shown on the opposite page, a bomb is swung up on a boom and allowed to drop against the target. In the photograph above, a six-pound M-69 hurls fire against a test wall about 25 feet from the plate against which it was exploded.

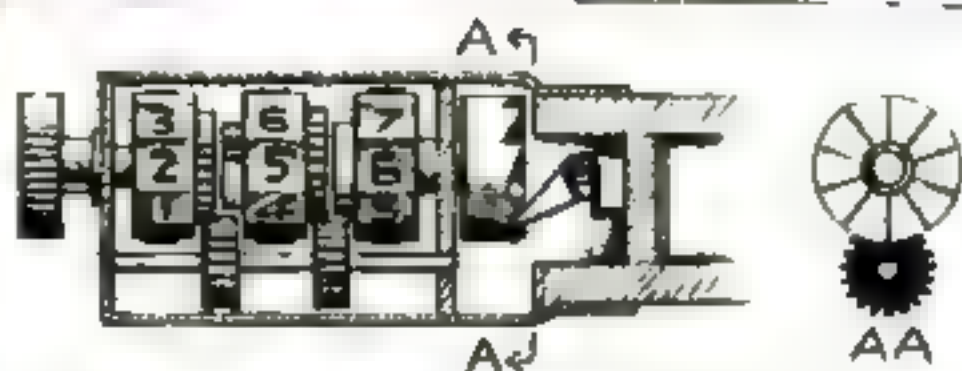
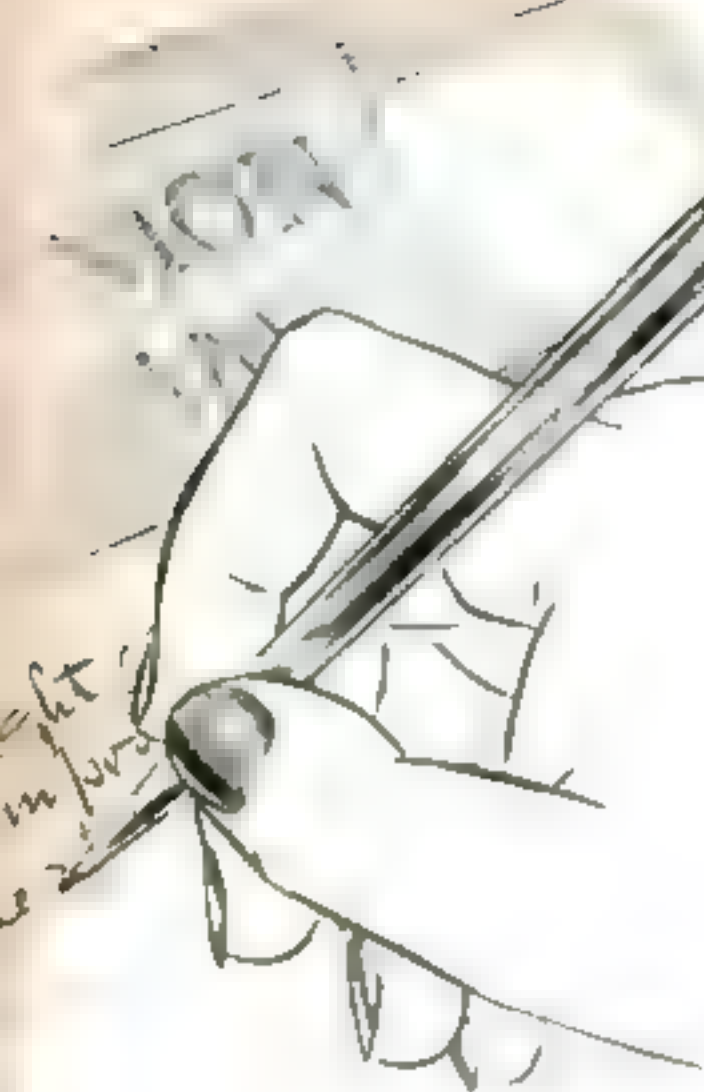
and six-pound bludgeons, but also with 100- and 500-pound fire-starting bombs for use on special targets.

The biggest incendiary now in regular use is a quarter-ton block-burner full of pyrogel. It looks like a thick, stubby cigar

and has two metal bands around its middle to facilitate handling. This bomb has plenty of penetrating power. After lunging into an enemy installation, it squirts out a pillar of fire which the devil himself must surely admire.

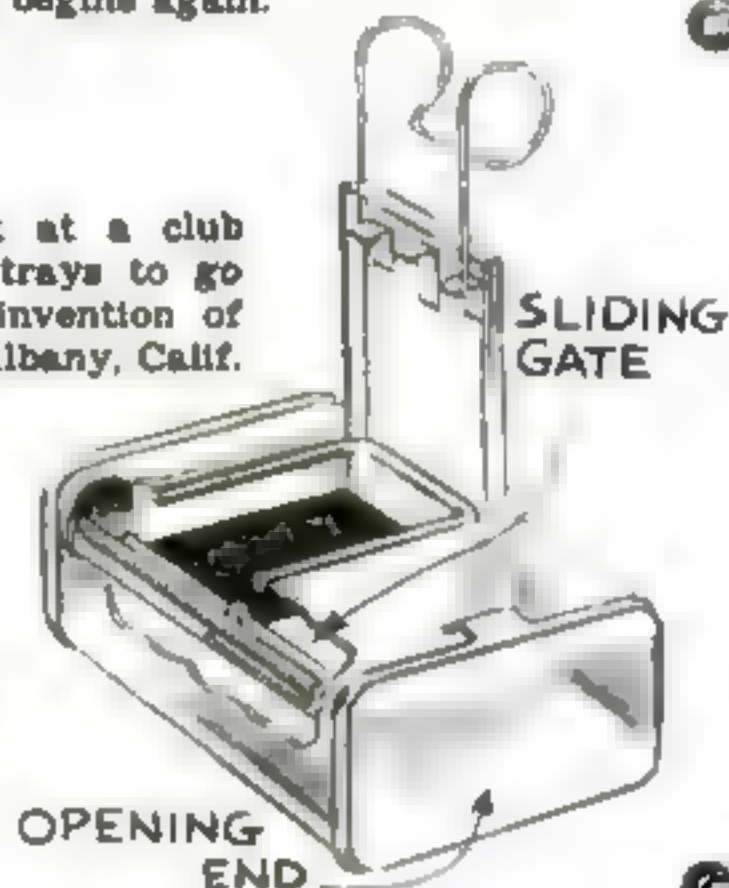
FLASH! An M-74 incendiary hurled by the air gun plows through a five-inch-thick concrete slab and flares up on the other side. Siding around the test chamber protects the testing personnel against possible ricochets. Falling speeds of 250 to 425 feet per second can be simulated to test roof-puncturing power.





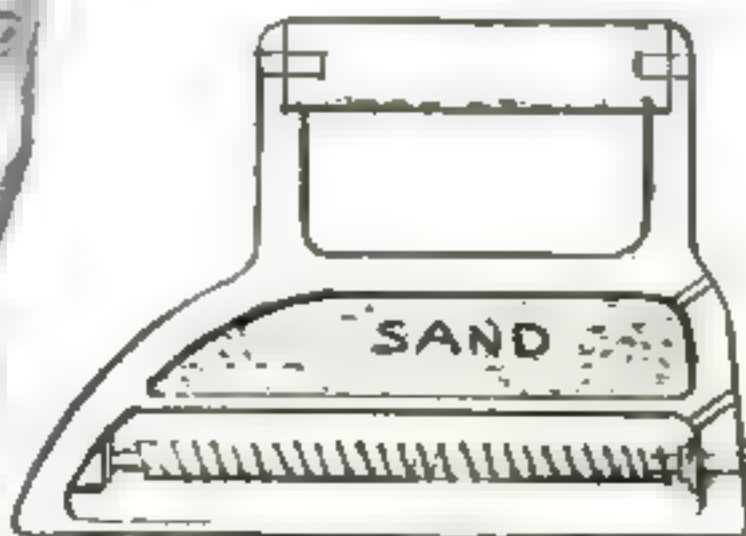
PENCIL COUNTS WORDS. Keeping track of the number of words you have written is made easy by a counting pencil invented by Miriam A. Du Lude, of St. Paul, Minn. At the end of each word you simply tilt the pencil up to right angles with the paper and push down on the point. A pawl-and-ratchet in the other end moves counter wheels like those that show the mileage driven in a car. It counts up to 999, then registers zeros and begins again.

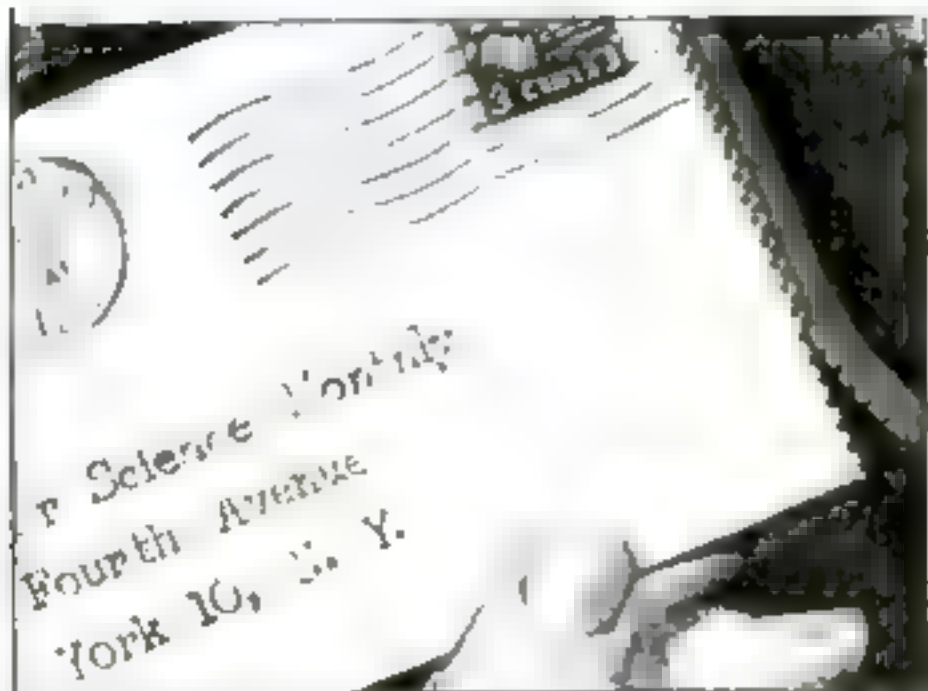
POCKET ASH TRAY. If you have ever been caught at a club smoker or a party where there weren't enough ash trays to go around, you will understand the reason behind this invention of James Kenneth Dodge and Martin William Johnson, of Albany, Calif. To save smokers the painful choice between dropping ashes and butts on the floor, or depositing them in a pocket, they have designed a little box that can be carried conveniently. Made of metal or some other fire-resistant material, it has a lid that locks securely to prevent spilling. Attached to the inside of the lid is a wire clip that can be unfolded and hooked over the back of a chair. Emptying is easy, when you get around to it; one of the ends is hinged so that it can be opened and the butts and ashes dumped out.



GLASS FLATIRON sounds like a contradiction in terms, but it's the best way to describe the electric presser devised by Leo D. Keller, Rochester, N. Y. A heating element is fixed in the bottom chamber of the "flat" between two comparatively thin layers of glass. Directly above the upper layer is a chamber filled with sand, which not only helps to conserve the heat below and shut off the glare from the heating element, but increases the weight of the "iron."

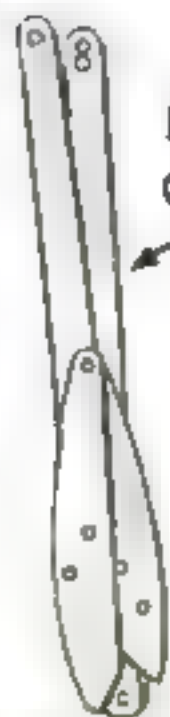
Between the two sturdy glass uprights a square wooden handle is secured by means of two hardwood pegs. Non-critical materials are used, and the metal content is reduced as much as 98 percent, both factors in wartime production.





RIP OPEN YOUR LETTERS easily and safely if they arrive in one of these perforated-end envelopes. Henry W. Stan, Chicago artist, who developed the idea, says it will save time looking for a letter opener and will prevent tearing or cutting important correspondence and checks. Already-printed standard envelopes can be perforated this way, according to the inventor.

PORTABLE HAMMOCK. You ordinarily think of a hammock as a fairly permanent fixture between two posts on the porch or two trees in the back yard. But here's one, invented by Clarence F. Benjamin, of Devon, Conn., that you can take along and set up anywhere you want it—at the beach, on a picnic, or in camp. The trick is in a supporting frame designed along the lines of a deck chair, with two long legs and two short legs on either side. When this frame is opened up, it stretches a strip of canvas hung between two crosspieces. This may sound more like a cot than a hammock, but a sag in the middle of the canvas strip gives the familiar cradling effect. The whole thing folds up into a bundle small enough to be carried on a bus or streetcar, or stowed away in an auto.



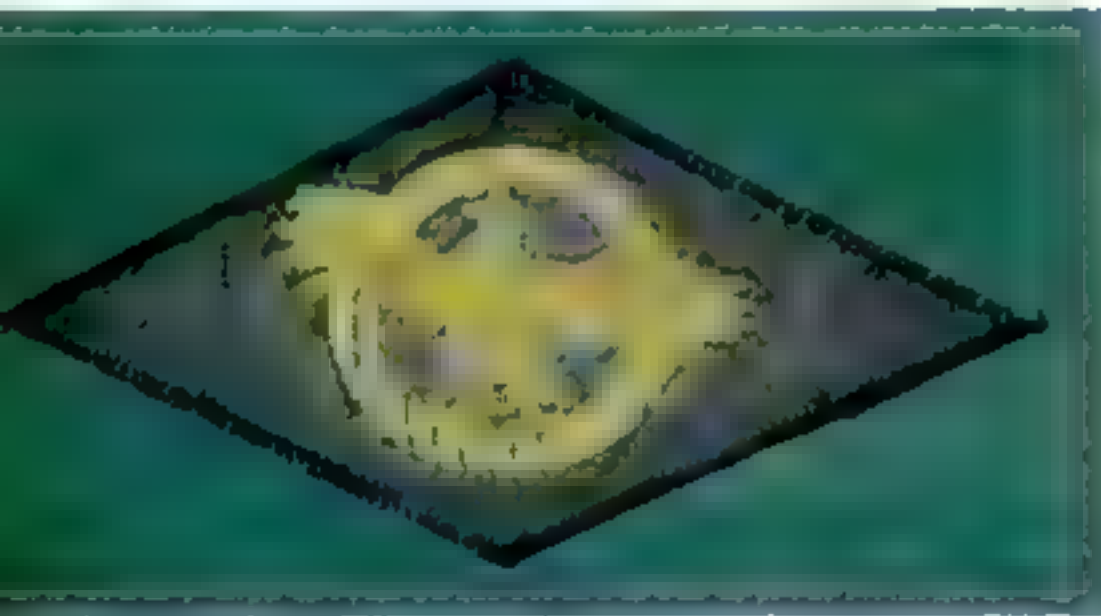
HAMMOCK
COLLAPSED



THREE-WAY SMOKER'S KIT provides the conveniences of a pipe, a cigar holder, and a cigarette holder. Taken apart, it has three pieces—pipe bowl, center section, and bit—each with suitable screw joints. Placed together, these form a conventional straight pipe. By combining only the center section and bit, a cigarette holder is obtained, while the bit section alone can be used as a cigar holder. The design of the outfit also makes it easy to keep the parts clean and free from "goo." Nat Silverman, of New York City, is the inventor.

A RING-TOSS GAME

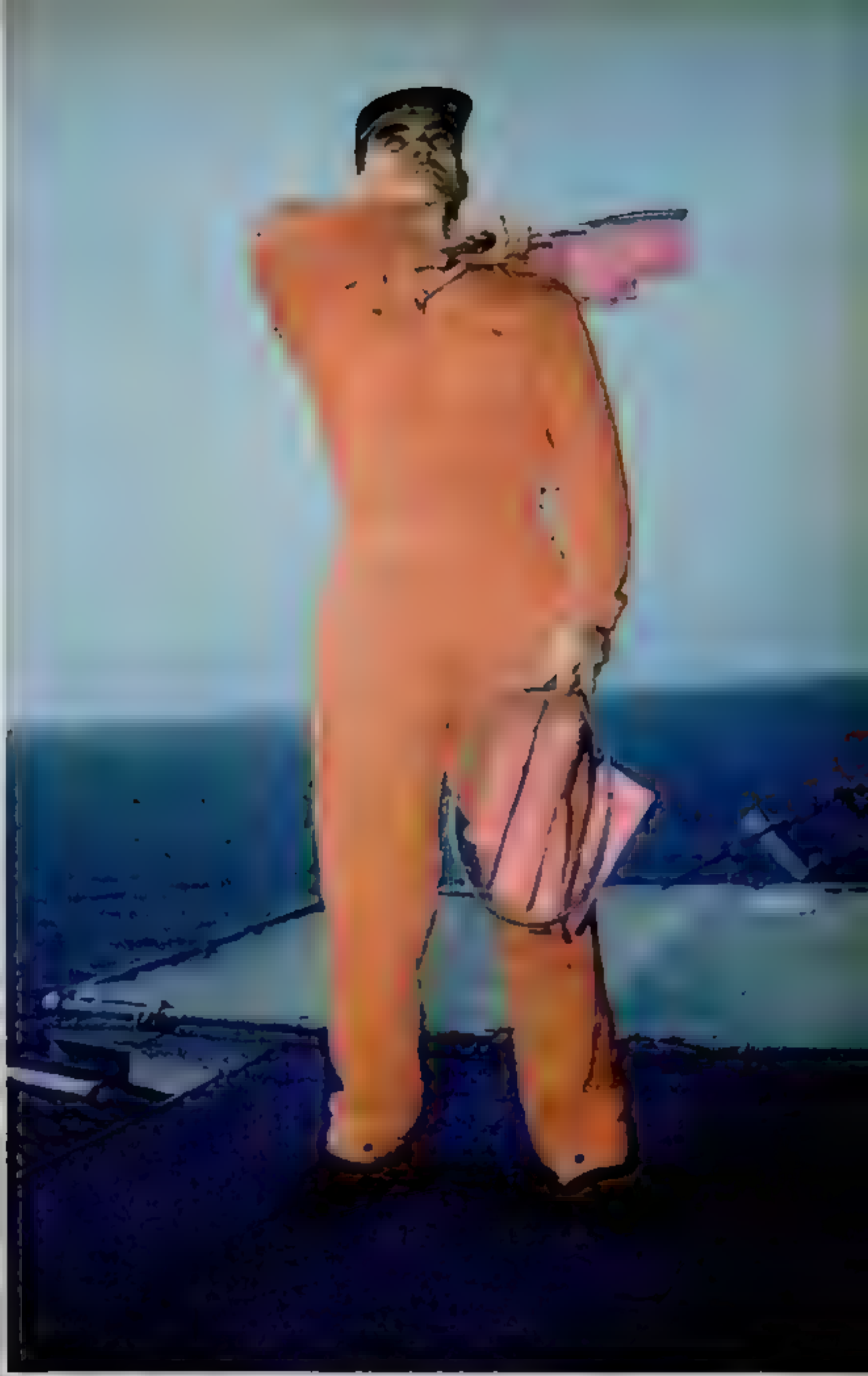
with a new twist is offered in "Toas-a-Score," manufactured by Originalities, of New York City. Each ring has a pointer on one side, and the disk that forms a base to support the stake is divided into sectors marked for different values. Each player tosses seven rings from a distance of five feet and adds up the score shown by the pointers. Players keep throwing in turn until one reaches the total of 500 or 1,000 points, whichever has been chosen as the goal. The fiber cone comes out of the disk for packing



HONORABLE DISCHARGE. When you see a soldier wearing this patch over the right-hand breast pocket of his uniform, it means that he is an honorably discharged veteran. Similar in design to the button worn by discharged veterans on civilian clothes, the patch has been authorized by the War Department for use by soldiers during the 30-day period in which they may wear their uniforms after receiving their discharges, and when they go back into uniform for parades and celebrations.

THE LCS (Landing Craft, Support) has been one of the most secret boat types in our beachhead flotillas. Here is a full-color photograph of one of these fast, rocket-firing speed-boats that lead invasion craft to enemy shores. You can plainly see the rocket-launching racks (P.S.M., Mar. '45, p. 82) that gave the LCS its nickname of "seagoing bazooka." It is armed also with machine guns and carries equipment for laying down smoke screens with which to blind the enemy during landing operations.





CUT THE GUN! The landing signal officer of an aircraft carrier tells an incoming pilot to shut off his engine before he hits the deck. His chemically treated red suit, one of several types used, makes him stand out conspicuously aboard the ship.

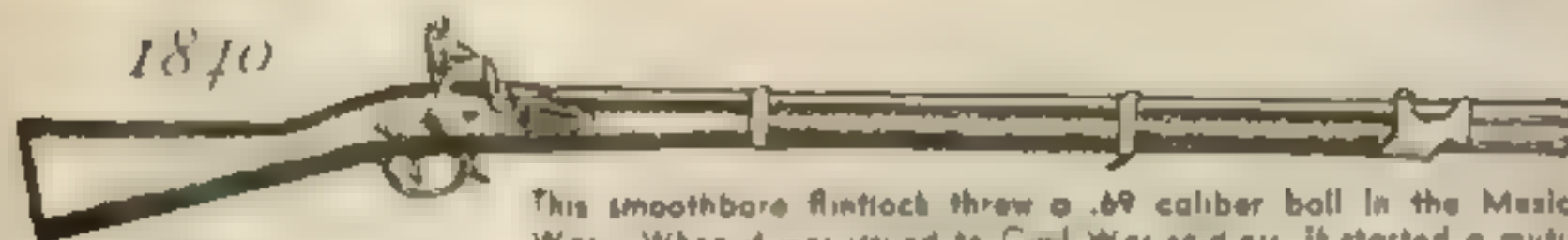


U. S. Rifles

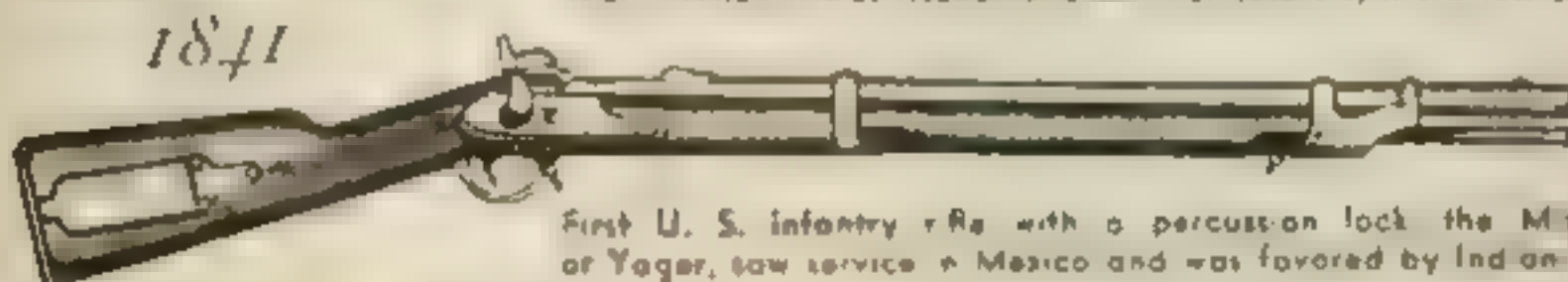
A HUNDRED years ago, the United States was preparing for war. In the summer of 1845, General Zachary Taylor moved to the Texas border with 2,000 Army regulars to guard against a threatened invasion. Nine months later the Mexican War had started.

The fighting of 100 years ago was quite different from the battles now being fought. Today airplanes, tanks, rocket artillery, and mines, rifles, and pistols all blend their individual noises into a cacophony of terror. In the Mexican War, rifles and pistols (with some artillery) provided most of the thunder. Santa Anna's dragoons depended more on their sabers than on their pistols when they charged the lancers of Santa Anna.

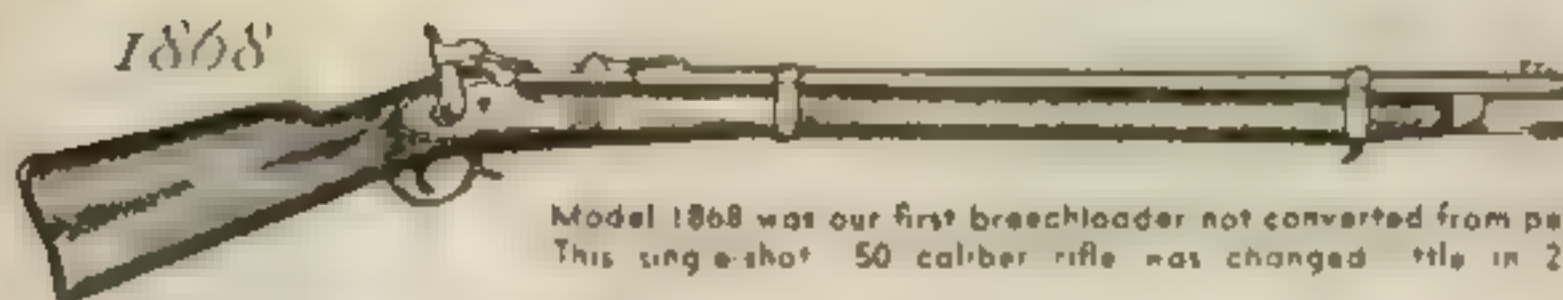
Just one century (1845 to 1945) carried us from the smoothbore flintlock to the Garand rifle.



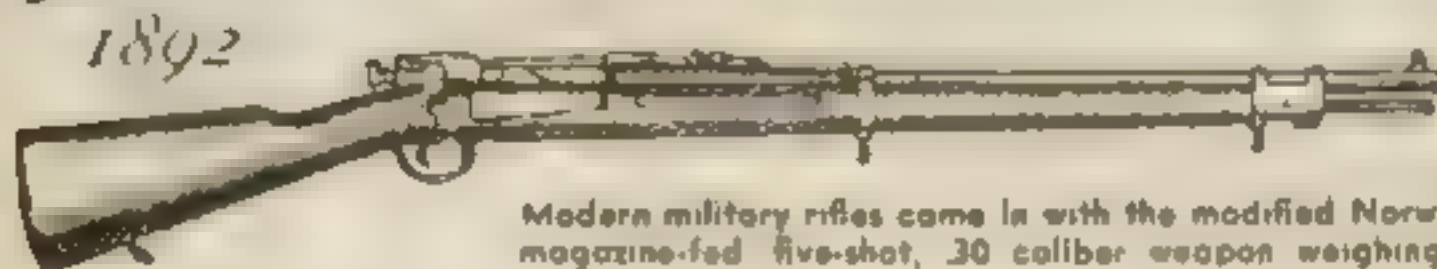
This smoothbore flintlock threw a .69 caliber ball in the Mexican War. When it was issued to Civil War soldiers, it started a mutiny.



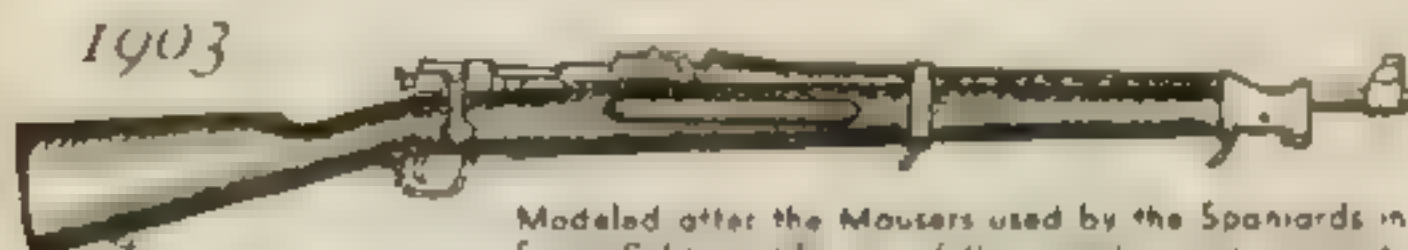
First U. S. infantry rifle with a percussion lock, the Mississippi or Yager, saw service in Mexico and was favored by Indian fighters.



Model 1868 was our first breechloader not converted from percussion. This single-shot .50 caliber rifle was changed little in 20 years.



Modern military rifles came in with the modified Norwegian Krag, a magazine-fed five-shot, .30 caliber weapon weighing 9½ pounds.



Modeled after the Mausers used by the Spaniards in 1898, our 1903 Springfield is still one of the world's most accurate military arms.



Firing eight shots as fast as you can pull the trigger, the semi-automatic M-1 Garand gives infantry firepower a tremendous boost.

and Pistols in Five Wars

The regular Army of that day was armed largely with smoothbore, muzzle-loading muskets and pistols, both of the flintlock type. Some units were equipped with the new percussion-cap weapons, which were a good deal more independent of the weather than the flintlocks.

The volunteer units and militia were, in some instances, better armed than the regular Army. In many cases they provided their own weapons, and they had no budget figures to explain to a querulous Congress that couldn't always see the need for new-fangled guns.

Among the new weapons that caught a soldier's fancy was a "revolver" put out by a fellow named Colt. One Texas Ranger

unit was armed with "six-shooters" and gained quite a reputation for the weapon, which was later adopted with modifications for the Army.

Rifles and muskets (smoothbore) fought side by side in (Continued on page 208)

By J. T. HOLMES

Lieutenant, AUS

Drawings by

JAN HOLMES



1836



Last Army flintlock pistol was manufactured until 1844. Converted to percussion, many were drafted for Civil War service.

1860



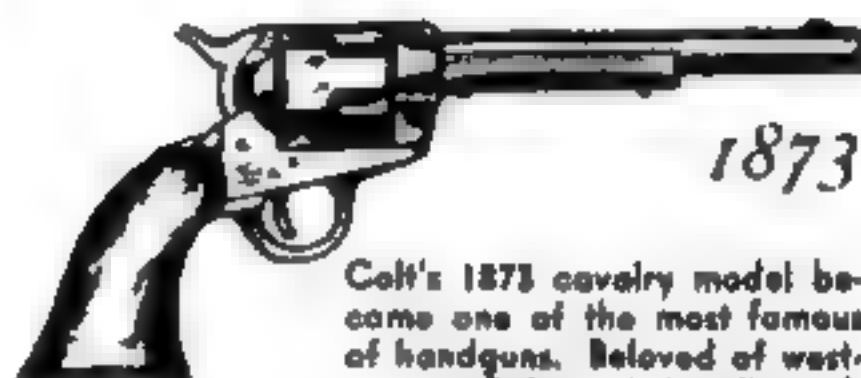
The Colt percussion six-shooter was so accurate that mounted troops used it as a carbine with a detachable stock, as shown in the small sketch.

1873



An early cartridge revolver was this Schofield-Smith & Wesson. It was a .45 caliber, six-shot, tip-up-barrel-type weapon.

1873



Colt's 1873 cavalry model became one of the most famous of handguns. Beloved of western gun-fighters, it is still good.

1911



Last word in military revolvers was this six-shot Smith & Wesson .45. About 150,000 were made for First World War use.

1917



The Colt .45 automatic was the principal side arm of World War I and is still the standard.



CLEAN SWEEP. The task of removing mines from England's shoreline is under way. Officers and sappers of the Royal Engineers are locating and exploding these containers of destruction which the British planted along their coasts when they expected enemy landings. Here, two Tommies painstakingly cover every square inch of ground with a mine detector listening for the tell tale buzz that means they have found the quarry.

BRITAIN DIGS UP HER BEACH MINES

SAFETY ZONE is clearly marked with strips of tape after the engineers have thoroughly covered the ground. Restrictions have been removed from most seaside towns but it will be many months before England's coast is absolutely free of mines.

BRITISH SAPPER carefully negotiates a barbed-wire obstacle as he brings in an intact mine. Note the sign warning trespassers of the danger area. The threat of invasion ended British authorities have ordered that the mines be cleared away and beaches made safe.





THOUSANDS OF MINES still stud the beaches along the coastline of England's "invasion area." However, Britons realize they were good insurance during the dark days of 1940 and 1941 and, judging by the number surrounding this member of the Royal Engineers, the job of digging them out is well under way.

EXPLODING a batch of mines on an isolated section of the British coast while a number of sappers watch from a safe distance away. Note the iron framework at the water's edge. Structures of this sort were erected as a further security measure to safeguard the "tight little isle" against the threat of invasion by Nazi armies.



How Clean Are Your Clothes?

Don't answer until you have read about Calgon and the way it helps soap and water do a job.

By KENNETH M. SWEZEY

WHEN the U S Army Quartermaster Corps recently ordered 500,000 pounds of sodium hexametaphosphate from a Pittsburgh manufacturer, it brought to the attention of the public a little-known chemical compound that for some time has been doing an important job in helping keep clothes and dishes clean, and factories and ships operating at top efficiency.

A chemical curiosity for nearly a hundred years, sodium hexametaphosphate was first made commercially available a dozen years ago as a conditioner for boiler water. Whenever hard water is used in producing steam a thick coating of calcium and magnesium scale grad-

ually builds up inside the boilers increasing rust and drastically reducing their thermal efficiency. Ordinary water softeners precipitate the harmful salts, but leave them as a sludge that has to be removed from time to time.

After a year and a half of investigation, Dr R E Hall, a Bureau of Mines researcher retained by the Hagan Company, of Pittsburgh, found that this rare sodium chemical was the miracle worker needed. Instead of precipitating the offending chemicals sodium hexametaphosphate kept them in solution, but it so tied them up in a complex compound with itself that they completely lost their identity, and along with that, all their harmful effects.

From conditioning boiler water, it was

SOAP ELIMINATOR MAKES CLOTHES CLEANER AND MORE SANITARY

Trade name for this cleaning solution is Calgon. Shake it in warm water, and you get no suds. It is not a soap, but a soap eliminator. Ows cleaning power to ability to remove dingy scum left by calcium and magnesium soaps that are insoluble in hard water and resist washing.

Place a laundered handkerchief in the Calgon solution, and shake again. This time suds are formed; they are produced by soap left in the fabric. On clothes, such remaining soap is what stands in the way of complete whiteness. On crockery and glassware used in the household, the soap film makes a breeding place for germs.



BUT . . . see the difference when sodium hexametaphosphate is used.

just a short step to softening water for all kinds of cleaning purposes. Grayness commonly seen in laundered linens, the traditional "bathtub ring," a cloudy film on washed glassware and dishes—refuge for bacteria that attack the intestinal and respiratory systems—are all due to insoluble calcium soap that cannot be washed away by ordinary methods. Sodium hexametaphosphate, the chemical that could be depended on to get rid of every trace of this offending scum, was put on the job.

Since Pearl Harbor, under the trade name of Calgon, nearly 10,000,000 pounds of the chemical have been put to use by the U. S. Army and Navy and Merchant Marine, not only to help speed up ships but to provide cleaner clothes and more nearly germ-free dishes. This is in addition to huge amounts that have been used in the boilers of various kinds of plants devoted wholly to the war effort. Until recently, the total output of the material was on a high-priority basis. Owing to increased production, some is now again available for civilian use.



PREVENTS BATHTUB RING. Calgon, added to hard, soapy water (right), prevents formation of scum usually resulting from the reaction of the calcium in the water with the alkali that is contained in soap.

WHEN IS A GLASS "CLEAN"?

Pour ginger ale into a glass that has been washed with soap and water; then into another rinsed with Calgon. The first bubbles furiously with carbon dioxide gas; other holds less longer.



SOFT WATER DE LUXE results from adding Calgon to the usual run of tap. Ordinary agents remove calcium and magnesium by combining to form insolubles that precipitate. But Calgon makes a soluble compound with chemicals and leaves the water completely clear (at right).

A **AMERICAN** GI's give the Jap GI credit for a number of things. The Jap has remarkable physical endurance, he can get along on very little, and he is not kidding when he says he is ready to die for the Emperor. But the Jap has quite a few weak points. His gear does not compare with American heavy equipment and, as a man, the Jap GI cannot think on his feet. As a result, plenty of Japs have been provided with the opportunity to die for the Emperor, often at the rate of ten for every American killed.

The ability of the Jap GI to keep going on next to nothing was a source of fascination for both Marines and soldiers during the Palau operation. Palau will be remembered as the show that set the stage for the Philippine invasion. For two months on Palau, Japs held out in caves, armed with rifles and grenades, resisting assault by bazookas, tanks, dive bombers, and point-blank artillery. Dried fish, biscuits, and seepage water was the bulk of the Jap supply of food and drink. Finally, of course, the Japs were rooted out.

The Jap cannot, it seems, think in large terms. His training concentrates on the fighting by an individual, rather than by an army. The Jap does not act like a good team man. Consequently, his thinking is usually in terms of one-man weapons, particularly the bayonet. Against Chinese coolies the bayonet doubtless is effective, but against an army of artillery and tanks it is little better than a nice try. The Japs are so hand-to-hand minded that even their light machine guns have bayonet attachments. The fondness of the Jap GI for his bayonet was particularly impressed upon me one day by a discovery made by my younger brother. I brought him a Jap bayonet and scabbard from Palau, but apologized because the blade would not go all the way down into the holder. I thought a bullet must have dented and pinched the

This captured Jap corpsman seems a little dazed by his first dose of American firepower. Wearing his navy uniform, he was painted by Lt. Jon Whitcomb, USNR, while resting at a U.S. field hospital



Is the Jap GI?

Second of a Series by
S/Sgt. BARRETT MCGURN

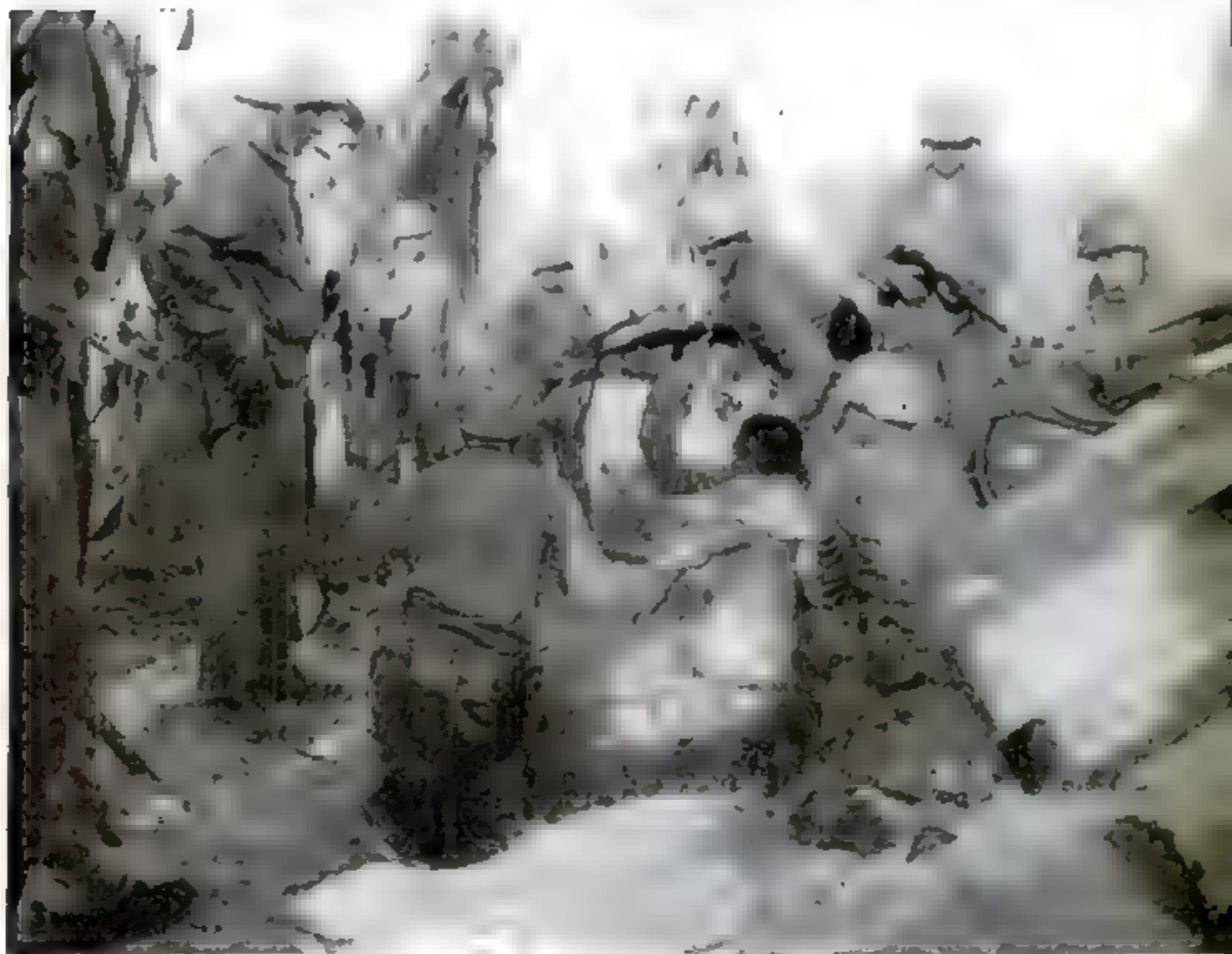
A tough, fanatical fighter—or a bungling amateur at modern warfare? A little of both, says this veteran of the Pacific.

sheath. My brother explored the scabbard and presently came up with a strip of gauze stuck deep inside. The Jap GI had fondly forced the cloth into the sheath to keep his bayonet from rattling. Nothing but top, shipshape condition of the piece was enough for its proud owner, it was evident. The bayonet, of course, was clean and well greased.

American ideas of combat take the opposite tack. Concentrating on teamwork, Americans use the heaviest possible gear. On the gray rock walls of Saipan today you can read the story of what happened

there—the same tale of teams against individuals. Alongside the caves pitting the cliffs you see big white dots where naval and artillery shells smashed at the Jap hideouts. Thinking in terms of man to man, the Japs holed up ready to shoot down anyone who entered the caves after them; reasoning along the lines of heavy gear, American forces fired lethal loads from miles distant. On Leyte in the Philippines, American GI's saw the same story again. Tanks advanced and Japs ran up with knives to attack the steel machines. The tanks, of course, merely backed up and

THE BELLYBAND worn by the Jap GI always interests Yanks. You can see one on this prisoner. For good luck, it is likely to be decorated with embroidery by his girl and outographs of other friends. Some American GI's have tried wearing them.





HE LOVES HIS BAYONET. A great believer in hand-to-hand fighting, he takes pride in this weapon and always keeps it clean and well greased. His light machine guns, even, are fitted with bayonet attachments.

... AND AMERICAN GOODS. Japs on Leyte were using U. S.-made radio equipment, soap, ammunition, automobiles, and cigarettes—all bought before the war or captured when Manila fell.



THE NIP GETS BY ON VERY LITTLE.

Rice and dried fish are the staples of his rations. On Palau, Japs held out for two months in caves, on nothing but fish, biscuit, and seepage water while holding off everything we could throw at them.

cut the wild Japs down with machine-gun fire.

The Jap GI's concentration on man-to-man ideas does work out occasionally to his advantage. It means that he becomes a skilled hand at camouflage. In the Philippines, American GI's noted both that Japs were using green fish netting and leaves on their helmets, and also that they had developed a "spider-trap" system of fighting oncoming American infantry. These spider traps were foxholes about the size of a man's torso, covered by boards over which grass had been fastened. When American soldiers advanced, the Japs hid beneath these trap doors until the wave had passed. Then they popped out and fired at the American backs.

Another advantage of the Jap attitude is its brutally realistic ideas about the wounded. On Guadalcanal, evidence indicated that the Jap high command sent the wounded to hold the line and get killed while the uninjured were evacuated to fight again another day. Of course, in the American way of doing things, priority is given to the quick air evacuation of the stricken.

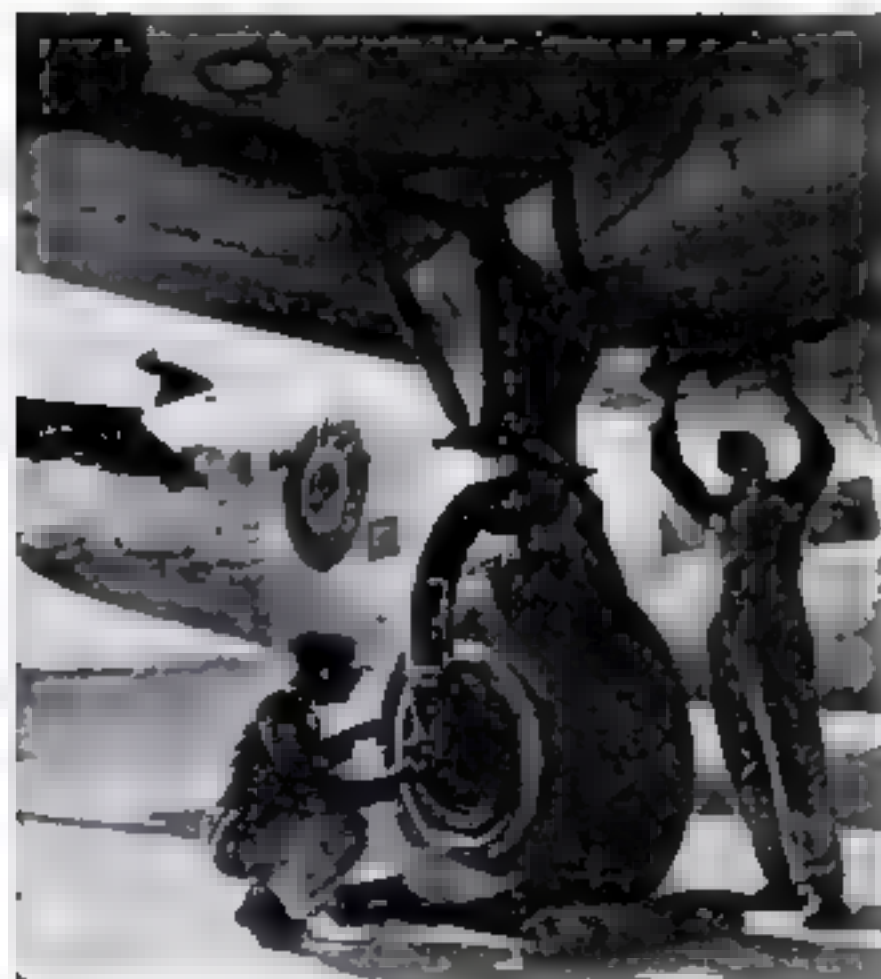
Outbalancing these Jap advantages are their drawbacks, however. The Jap often is able to cook up a pretty good master plan, but when anything goes wrong the Jap GI has no idea how to alter the project to advantage. Pfc. Sebastian B. Porretto, who used to be a *(Continued on page 206)*



Flying out of London in easterly and westerly directions, with Sydney, Australia, as the contact point, RAF Transport Command planes cover the 24,706-mile-long, globe-encircling route in nine days, making 13 stops.

U. S. and Britain Complete Round-the-World Air Lines

Both the RAF and the AAF fly regular schedules with high-priority men and supplies.



Members of the RAF Transport Command ground crew at Lindbergh Field, San Diego, ready a Liberator C-87 for the 7,370-mile trip to Sydney, Australia.

TWO globe-encircling networks of air routes—one flown by the Royal Air Force Transport Command and the other by the U. S. Army Air Forces Air Transport Command—are in operation, it may now be revealed. These round-the-world lines have established the speediest possible means of transporting highest-priority medicines and other material, officers, men, and mail for all Allied nations to points where they are urgently needed.

The British operate two separate legs on their route, which was inaugurated on Nov. 4, 1944, maintaining regular twice-a-week schedules in both directions. On the 11,489-mile eastern half of the line, British Lancasters and Consolidated C-87 Liberator Expresses serve between London and Karachi, India, with stops at Lisbon and Cairo. At Karachi, C-87's, which make all the over-water flights, take the cargo to Colombo, Ceylon; Perth, in western Australia, and Sydney, terminal of the line.

One section of the 13,217-mile western route passes over the United States. After the London-to-Montreal hop, Douglas C-47's take over for the transcontinental run, via Washington, D. C., and Dallas, to San Diego. On the transpacific jump to Sydney, stop-overs are made at Honolulu; Canton Island; Fiji Islands, and Auckland, New Zealand.

So rigidly are schedules maintained that



The four-engined C-87 eats up 2,290 gallons of high-octane gasoline each time it makes the transpacific crossing in Britain's globe-girdling air supply line. Two of the 21 Britons at San Diego do the "serving."

personnel and war goods reach the other side of the world in 4½ days.

The USAAF Air Transport Command, which has flown thousands of missions over its more than 180,000 miles of air routes throughout the world, recently began regularly scheduled flights between Calcutta and a base north of New Guinea, via Exmouth Gulf, Australia, which filled a gap to make the ATC line a globe-encircling route. The first ATC land-plane flight on this link—a hop of 8,200 miles from Ceylon to Carnarvon, Australia—was made in the fall of 1943 by a crew that carried a group of U. S. Senators around the world.

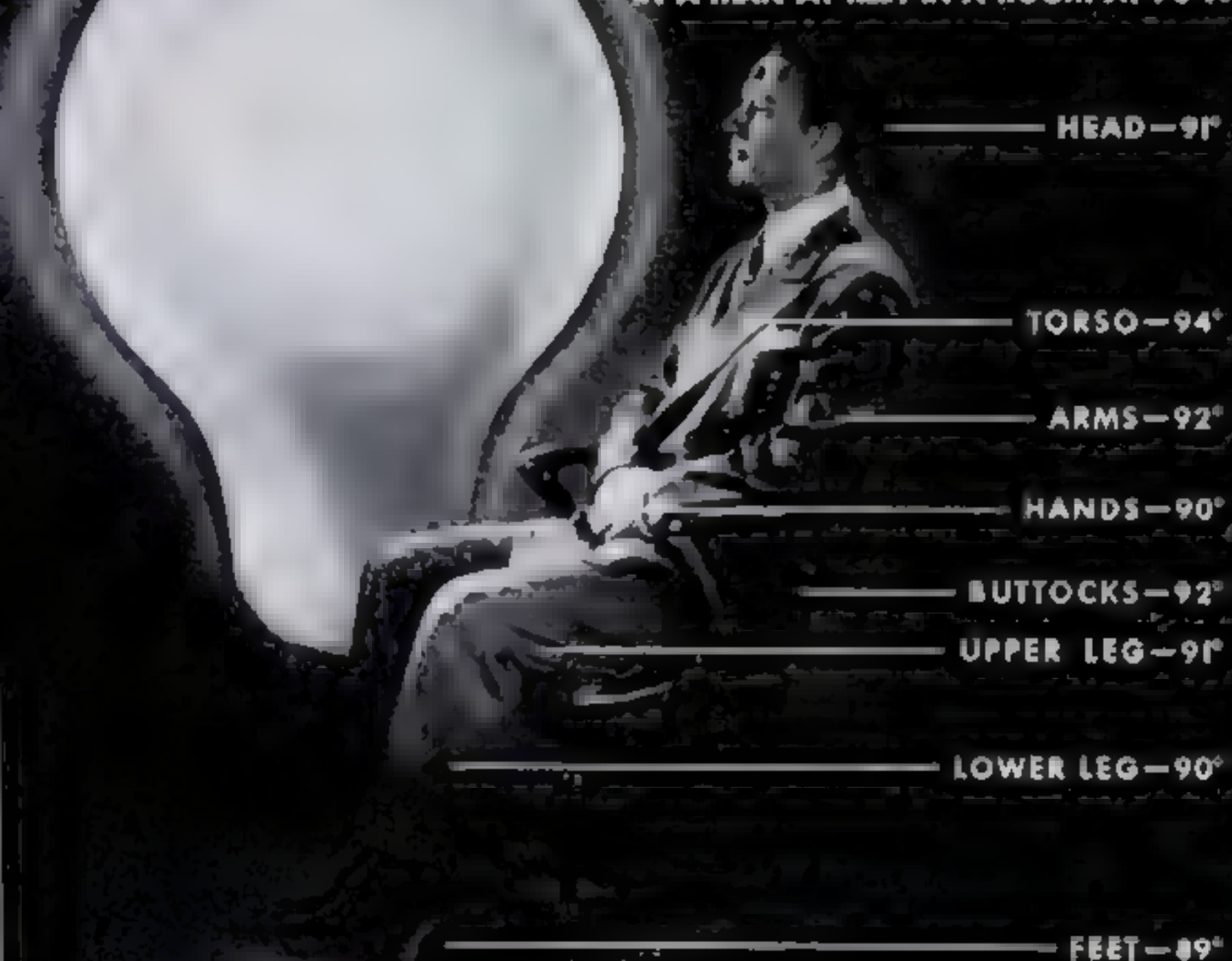
The flight from Ceylon to Exmouth Gulf is made in 15 hours, with seven hours' flying time between Calcutta and Ceylon. ATC flies from Florida to Calcutta, by way of Africa, in less than 80 hours, and regular flights from Australia to California are made in a little under 40 hours—ANDREW R. BOONE.

Ground crews spend 500 man-hours on each C-87 before it makes the over-water hop to Australia.



Man Puts Out Heat of a 100-Watt Lamp

HOW SURFACE TEMPERATURES VARY
IN A MAN AT REST IN A ROOM AT 70°F.



Aided by the yardstick of body heat, such as shown above, scientists prescribe gear for our fighting men that protects them from severe cold. Under wartime pressure, new secrets of keeping warm are being found.

What's Involved in Keeping Warm

By GOLD V. SANDERS

ALL of us are going to keep warmer and more comfortable in the future because some hardy individuals have spent many uncomfortable hours in icy chambers while researchers took notes on their miseries.

As a result of intensive wartime research, we have much precise information about the human body's reactions to extremes of heat, cold, and altitude. Among other things, it

has been established that the thickness of clothes, rather than the material of which they are made, determines how much protection is provided, since it is the air trapped in the garments that determines their insulation value.

The findings have been given immediate application for soldiers who have to fight under arctic conditions. Unless men are very active at below-zero temperatures the bulk required for protection is impractically



This combat dress (front and rear views) of a B-29 crewman would be far more bulky if it were not scientifically designed. The inner layer is electrically warmed with the correct amount of heat going to each part.

large. For example, to maintain comfort while sitting at 40 below zero a man requires about three inches of clothing everywhere. For this reason it was necessary to develop heated clothing for heavy-bomber crews.

Many of these findings will benefit us after the war, since the thermal protection of any item of clothing can now be determined with precision.

The surface temperature of the human body has been studied and measured in many experiments. All earlier tests of this kind were made on human "guinea pigs," but more recently a robot of copper has proved to be an even better subject for use in these important tests.

Scientists now maintain, with utmost confidence in their [*\(Continued on page 205\)*](#)



Copper man (left) tests an airman's jacket. Because his temperature is standardized in all parts, he is a perfect "guinea pig." Two variable transformers on chest control temperatures of the hands and feet.

An idea of the "circulation system" of Mr. Copper Man may be gained from the foot-ports below. He is so wired that all the areas of his body radiate different degrees of heat, as in a human being.



WEATHER IS FUNNY

AN AIR-MINDED world is becoming more conscious of the strange actions of the weather. Our flyers have learned that cigarettes will not burn at high altitudes, that water will begin to boil in the stratosphere, and that waterproof watches explode from inner high pressure. Below are a few of the paradoxes of Mother Nature's outdoors, some of the things with which the meteorologist must contend. Nothing seems quite so illogical as weather, as these items will show.

We See the Sun and Moon When They're Not There!



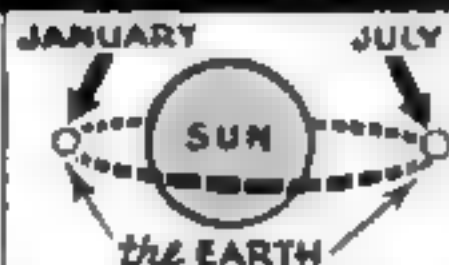
A star's light bends when it passes through the dense, wet air surrounding the earth. Thus, a star may be "seen" though it is beyond the horizon. And the sun "sets" after it is below the horizon.

More Air Goes Up Than Comes Down!



Measured in mass, the amount of air rising is greater than that coming down—that is why air circulates. And ascending air contains more water than descending air, for precipitation dries the atmosphere.

We're Colder When the Sun Is Closest to the Earth!



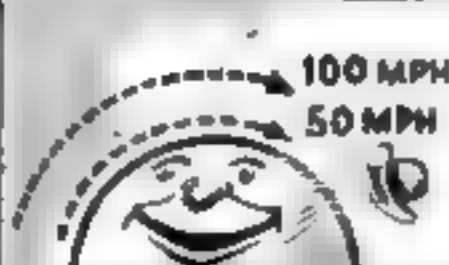
The earth's orbit around the sun is an ellipse which brings it 6.6 percent nearer the sun during our Northern Hemisphere winter. But the sun's low elevation, as we see it, and short days cause the coldness.

You'll Cool Off As You Fly Toward the Sun!



The sun does not heat the air; it shines right through it. But the earth absorbs the heat of the sun, warming the air surrounding it. Fly away from the earth and you climb gradually into colder atmosphere.

Earth Puts the Brakes on the Global Winds!



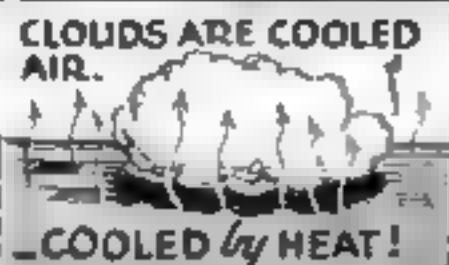
The rotation of the earth creates the global winds, yet the air closest to the globe is slowed by the earth itself. The "friction layer" (0 to 5,000 feet) is so called because it checks the speed of wind.

Icebox Over the Equator!



Because the intense radiation over the equator causes air to rise to greater heights, that air is eventually cooled to lower temperatures than those at the North or South Pole. Flight records show -85°F.

To Cool Air, Heat It!



Air cools by losing heat energy. Heating an air mass makes it rise, expand, lose energy, and thereby cool. A cloud is warm air cooled by ascending and expanding.

WHAT FUTURE HAS
THE DIRIGIBLE?

AIRSHIPS



FOR THE COMING AIR AGE

By HAL BORLAND

WHEN the giant airship *Hindenburg* exploded into flames at Lakehurst, N. J., on the evening of May 6, 1937, many people believed that it was the end of a noble experiment in lighter-than-air travel.

It was, indeed, the end of an era in that field. But a new era began soon after Hitler's armies invaded Poland less than two and a half years later. American airships, nonrigid blimps, were drafted into patrol duty along our coasts. Little was said then about what those airships were doing, and only a little more may be said to-day about what they have done. But it is known that literally hundreds of them have piled up a log of hundreds of thousands of hours of strenuous patrol and convoy duty with a phenomenally low casualty record.

On the basis of this record, backed by an impressive mass of figures and facts, American airship men are now prepared to bid for a place in the world's postwar commercial aviation program.

Anyone who looks at the over-all picture of this air program will have trouble shrugging off the airship. Its advocates offer—and back with facts—many reasons for its revival in world commerce. Chief among the reasons are the airship's speed and safety, its economy of operation, its reliability, and its load capacity. And Americans can add this clincher: we have a virtual world monopoly on helium, safest known gas for inflating lighter-than-air craft and clearly the key to successful operation of airships.

It was the Germans who developed the airship and proved its commercial worth. Count Ferdinand von Zeppelin did his major work of development before and during World War I. Zeppelin, incidentally, made

his first flight here in America in 1863, in a captive observation balloon of the Union Army. He had come here as a military observer, remained to fight for a time, and returned to Germany before the Civil War had ended.

During the years of trial and development, nearly half a million passengers were carried by airships without a single passenger fatality until the *Hindenburg* fire. The really significant figures come from the records of the *Graf Zeppelin* and the *Hindenburg*, both built specially for transoceanic passenger and freight trade.

The *Graf Zeppelin* made 590 commercial flights totaling 17,177 hours and 1,053,618 miles. She made 144 ocean crossings and carried more than 13,000 passengers and 250,000 pounds of mail and freight. Her log shows a flight to the Arctic and one to Egypt, and she circled the globe. She was re-

tired without ever having had a serious accident.

The *Hindenburg*, larger and more modern than the *Graf Zeppelin*, was in service less than a year. But in that time she made 63 flights, 37 ocean crossings, was in the air 3,088 hours, flew 209,527 miles, and carried more than 3,000 passengers and 41,000 pounds of mail and freight.

American blimps also have a peacetime record well worth noting. Until they were taken over by the Navy, Goodyear's commercial blimps had made 152,441 flights totaling 93,096 hours and 4,166,390 miles. They had carried 407,171 passengers without so much as a minor injury to anyone.

Military airships—that is, those rigid-framed dirigibles with which we and other nations experimented for 15 years after 1920—have had no such record of success. Five of those huge ships met destruction in tragic fashion, and the world still remembers them. Each of those disastrous accidents, however, had its reason.

In August 1921, the British *ZR-3* broke in two and burned, causing a loss of 62 lives. The *ZR-3* was a hydrogen-filled ship copied

Lighter-than-air craft bid for a place in the postwar sky—with speed, safety, load capacity, and reliability as their chief selling points.

A U. S. Navy blimp snuggles up to its mooring mast at Lakehurst, N. J. These little airships have made a fine record in patrol, escort, and rescue work.

FORERUNNERS OF THE LIGHTER-THAN-AIR GIANTS



Heliaens were used for reconnaissance in the Civil War. Here the Washington is being sent aloft from a flat barge.



Count Zeppelin's second airship, the LZ-2, was launched in November 1905, from Lake Constance, Germany. It was 420 feet long and was inflated with 390,000 cubic feet of hydrogen gas.

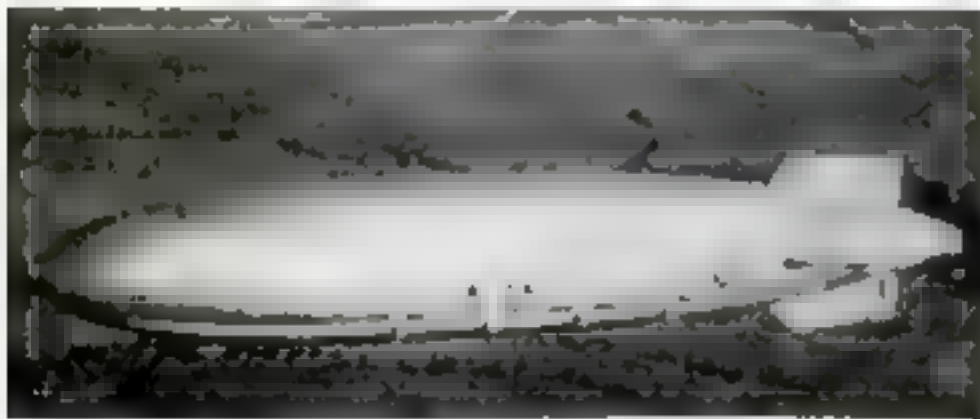
from a lightly built German "zep" captured at the end of World War I; it was flown by a crew unfamiliar with air stresses.

In December 1923, the French *Dismude* vanished over the Mediterranean with a crew of 53 men. The *Dismude* was a light-

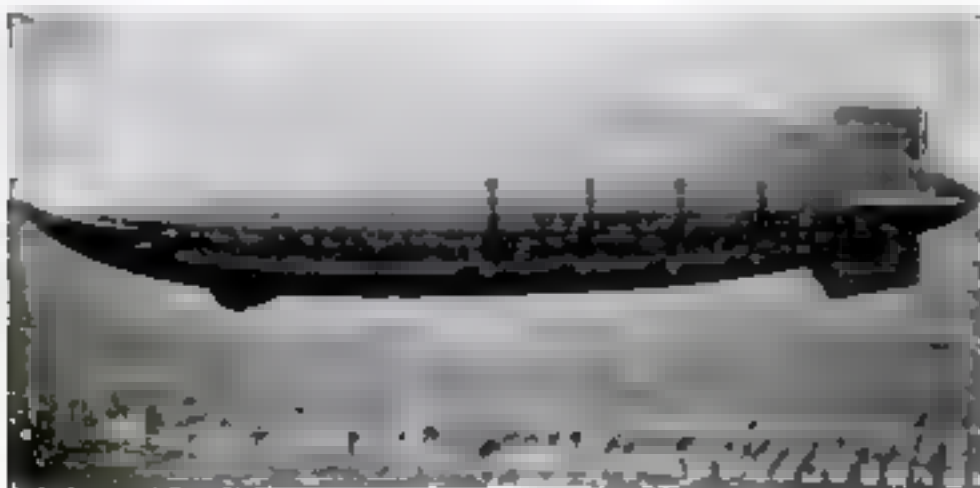
weight, hydrogen-inflated German ship seized after the armistice, and the French crew was inexperienced.

In September 1925, the U. S. Navy's *Shenandoah* broke in two in a line squall near Ava, Ohio, and 14 of her crew were lost.

THESE SHIPS SHARED THE FATE OF THE ILL-STARRED HINDENBURG



U.S.S. Akron (above) crashed into the sea off the coast of New Jersey in 1933 when she ran into a violent thunderstorm about which her crew should have been warned. In 1935 the U.S.S. Macon (below) was forced down on the sea off the Pacific coast and lost. She had been sent on maneuvers with the fleet while alterations were incomplete.



DISASTER. The most spectacular aircraft tragedy occurred when the giant German dirigible Hindenburg exploded and burned with a loss of 36 lives on May 6, 1937, at Lakehurst, N. J. Believed caused by static electricity, this catastrophe proved the hazard of using inflammable hydrogen gas as a buoyancy medium. America's monopoly on the virtually accidentproof helium gives her a big edge.

THAT WILL SOAR THROUGH THE SKIES OF TOMORROW



On the LZ-4, Zppelin experimented with the rudder mounted behind the body tip. Later this was split and moved forward on the hull, as in today's ships.



The U. S. Navy accepted its first lighter-than-air craft, the DN-1, in April 1917. Because of overweight and design defects, however, it was a failure and was abandoned.

The *Shenandoah* was a modified copy of a German "zep" built in 1916, a touchy lightweight in which it was suicidal to enter any violent storm area.

In April 1933, the U. S. Navy's *Akron* crashed into the sea off the New Jersey coast

with a loss of 73 lives. She ran blindly into a violent thunderstorm and, because of a faulty altimeter, slammed her tail into the waves while trying to maneuver out of the storm.

In February 1935, the U. S. Navy's *Macon*





IN WAR our Navy's helium-inflated blimps have proved deadly against Nazi submarines, sinking many of them and reportedly chasing others away from ship convoys. Also, they have made many air-sea rescues.

was forced down off the Pacific coast and was lost. Two men died with her. She, too, was fundamentally a sound ship. But she was ordered to put out on fleet maneuvers before changes ordered in her aft structure had been completed, and she lost a fin in a bit of rough weather. Subsequently, she lost a good deal of gas and settled on the ocean, where the waves ripped her to pieces.

Of these five military airships, only the *Akron* and the *Macon* were even comparatively modern. Airmen who know what happened insist that neither ship should have been lost. Any sensible flyer goes around a storm, not into it, and with today's aerology he knows when he is approaching a storm area and how to avoid it. Both the *Graf Zeppelin* and the *Hindenburg* met and mastered such situations repeatedly. In fact, the fate of these military airships merely emphasizes the safety record of the *Graf Zeppelin* and the *Hindenburg*.

In considering air travel, we naturally think of speed. And in thinking of speed over long distances, most of us turn in-

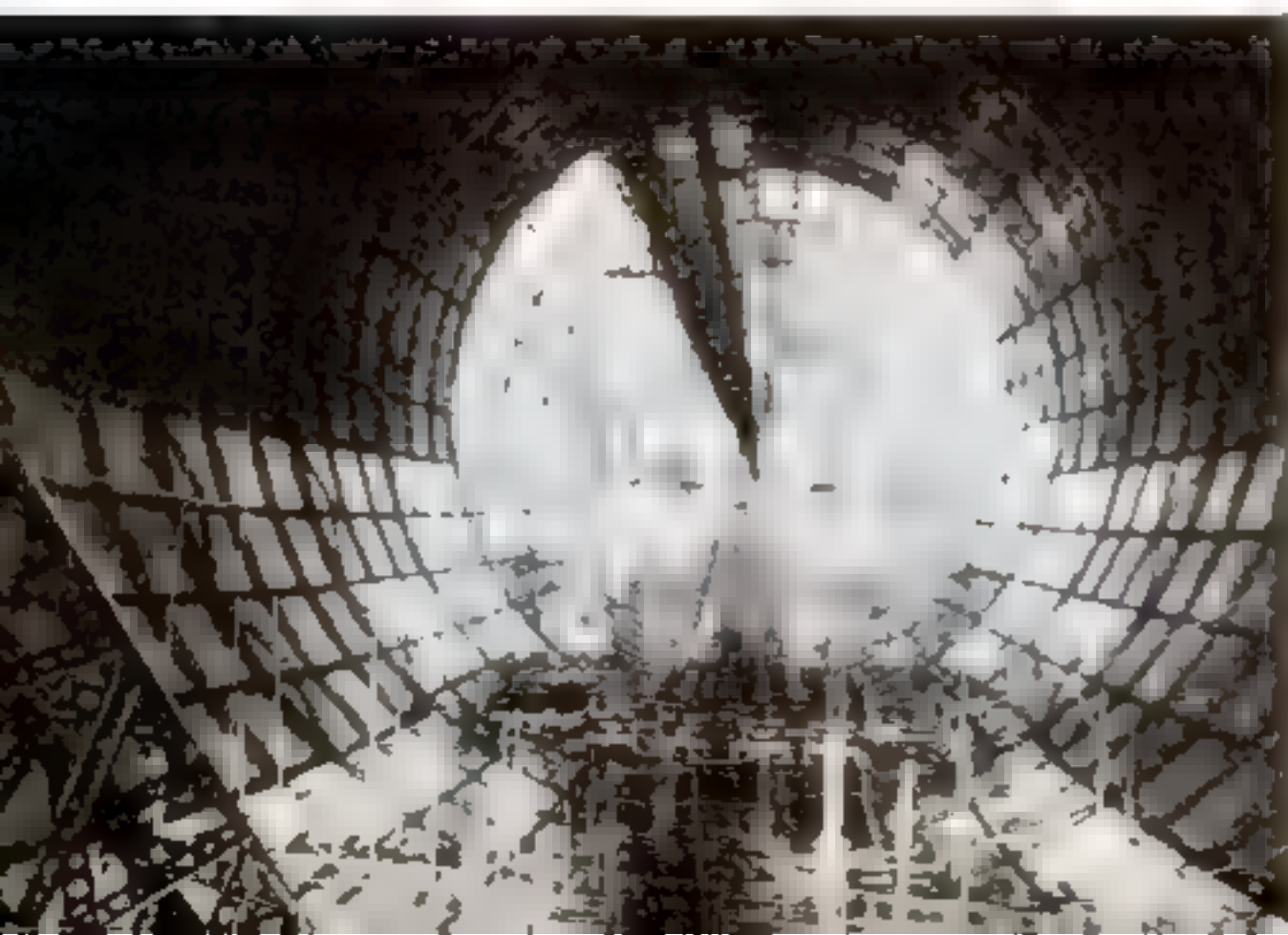


IN PEACE dirigibles such as the *Norge*, used by Roald Amundsen to fly across the North Pole from Spitsbergen to Teller, Alaska, in May, 1936, will be invaluable in charting unexplored areas of the world.

stinctively to the 350-miles-an-hour airplane. But over long distances, factors other than maximum speed under ideal conditions must be considered. There are layovers, turn backs, delays, overnight stops. The longer the trip, the more these factors affect elapsed-time speed.

Rear Admiral Charles E. Rosendahl, probably America's most experienced airship man, has compiled eye-opening figures on comparative air speeds. He points out that over a five-year period ending late in 1941 transpacific commercial planes on schedule between San Francisco and Hong Kong showed elapsed-time averages of about 35 miles an hour westward and 33 miles an hour eastward. Bad-weather delays, circuitous routes, and overnight stops greatly reduced actual flying time and increased elapsed time.

Admiral Rosendahl's figures also show that commercial air travelers bound across the North Atlantic just before the present war were taken in the winter months by a roundabout southern route requiring an



This view of the inside of the German airship L2-130 before its completion reveals its immensity. Passenger cabins are located in the center of the cavernous interior. Part of the outer fabric covering has been laced over the frame, but the ballonets have not yet been installed. These contain the gas for controlling the ship's ascent or descent and for maintaining pressure on the outer envelope. Note truss girder high over cabins, running through the center of the enormous structure.

average of four days and 16 hours per passage. This, according to Admiral Rosendahl's calculations, gave them an average elapsed-time speed of only about 30 miles an hour.

The only comparable airship figures are those of the *Graf Zeppelin* and the *Hindenburg*. In 1929 the *Graf Zeppelin* made the trip from Japan to San Francisco in 69 hours, at an average speed of nearly 75 miles an hour, elapsed time. The *Hindenburg's* average operational speed, also elapsed time, was nearly 65 miles an hour for all her ocean passages. The passenger-plane schedule from San Francisco to Hong Kong was six days and seven hours. An airship with the *Hindenburg's* average performance would make the same trip in about four and a half days.

The airship's advantage here comes from the fact that it does not have to make stops for refueling, that it can halt in mid-air for motor repairs, that it has sufficient range to go far around a bad-weather area and can even seek a clear area and cruise with only enough movement for steerageway until bad weather ahead clears up. In fact, the *Hindenburg's* record shows that she never failed to make a scheduled commercial trip; she took off several times when the weather was so bad that all airplanes were grounded; and she never was more than 12 hours late on a scheduled North Atlantic westward crossing or six hours late on an eastward crossing. Also, its ability to hover permits an airship to delay its landing if that is necessary. Once, warned by radio of a revolution, a German airship postponed her landing at Recife, Brazil, and merely headed into the wind for two days.

For hauls of 1,000 to 2,000 miles the airship cannot compete with the airplane in speed, though it can offer stiff competition

in economy of operation. Passenger revenue alone covered more than 75 percent of all costs of operating the *Hindenburg*, including amortization, and the ship never carried a capacity load of paying passengers.

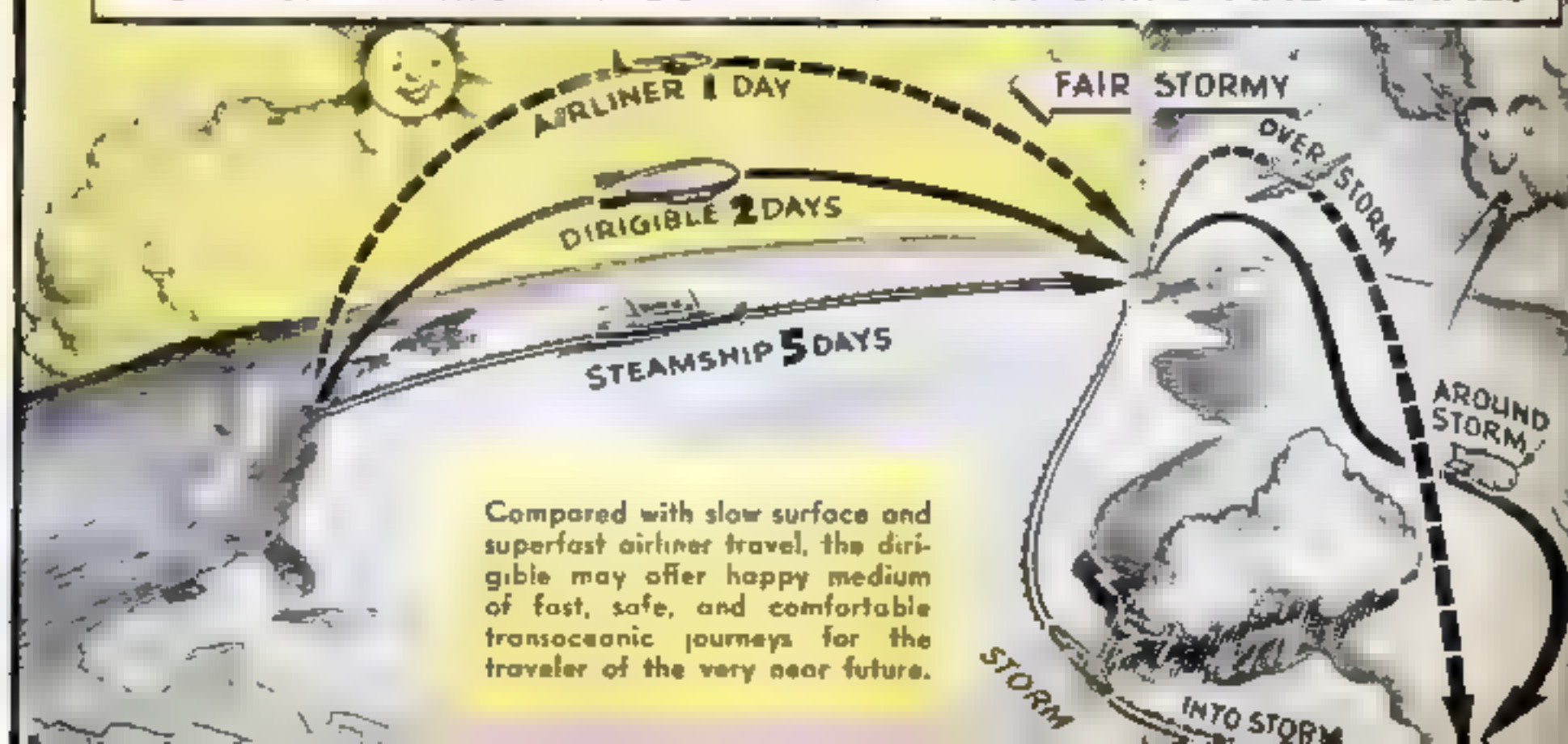
Passenger comfort is another notable factor. The *Hindenburg* had 25 two-berth staterooms, smoking and writing rooms, promenades, three bars, and deck space totaling an eighth of an acre. Her noise level was rated at 61 decibels, lower even than that of a Pullman car. There was not enough vibration to ripple the surface of a glassful of water. And because of its size, the airship absorbs the air bumps which toss an airplane around to the discomfort of its passengers. According to the records, there never was a case of airsickness or seasickness on either the *Graf Zeppelin* or the *Hindenburg*.

Can we build good airships? We built two, the *Akron* and the *Macon*, both of which were lost, according to findings of official courts of inquiry, because of operational mistakes. Goodyear now has in blueprint plans for a ship of 10,000,000 cubic feet capacity, half again as large as the *Macon* and more than a third larger than the *Hindenburg*. Tested designs are definite improvements on the best that the Germans ever made. New materials made available since the war began will permit still further improvement.

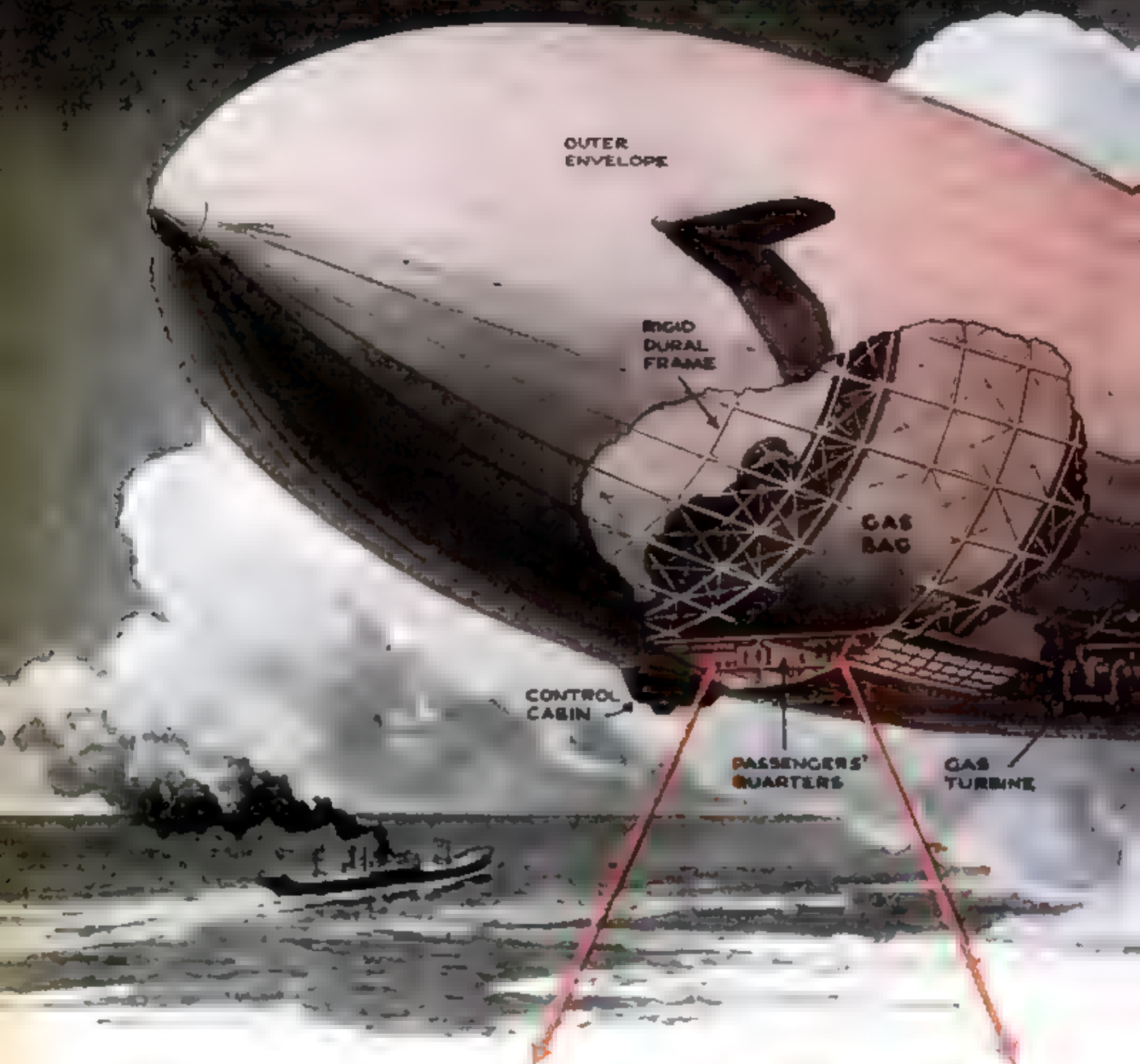
Professor J. C. Hunsaker of the Massachusetts Institute of Technology, a noted aeronautical scientist, sees the transatlantic services of the future falling into three categories: a five-day steamship service, a one-day airplane service, and a two-day airship schedule.

"Consideration of the operating record of the *Hindenburg* in North Atlantic service," he says, "leads to the conclusion that a similar airship of 28 percent greater displace-

HOW THE DIRIGIBLE COMPARES WITH SHIPS AND PLANES



WILL SHE BE QUEEN OF THE SKY?

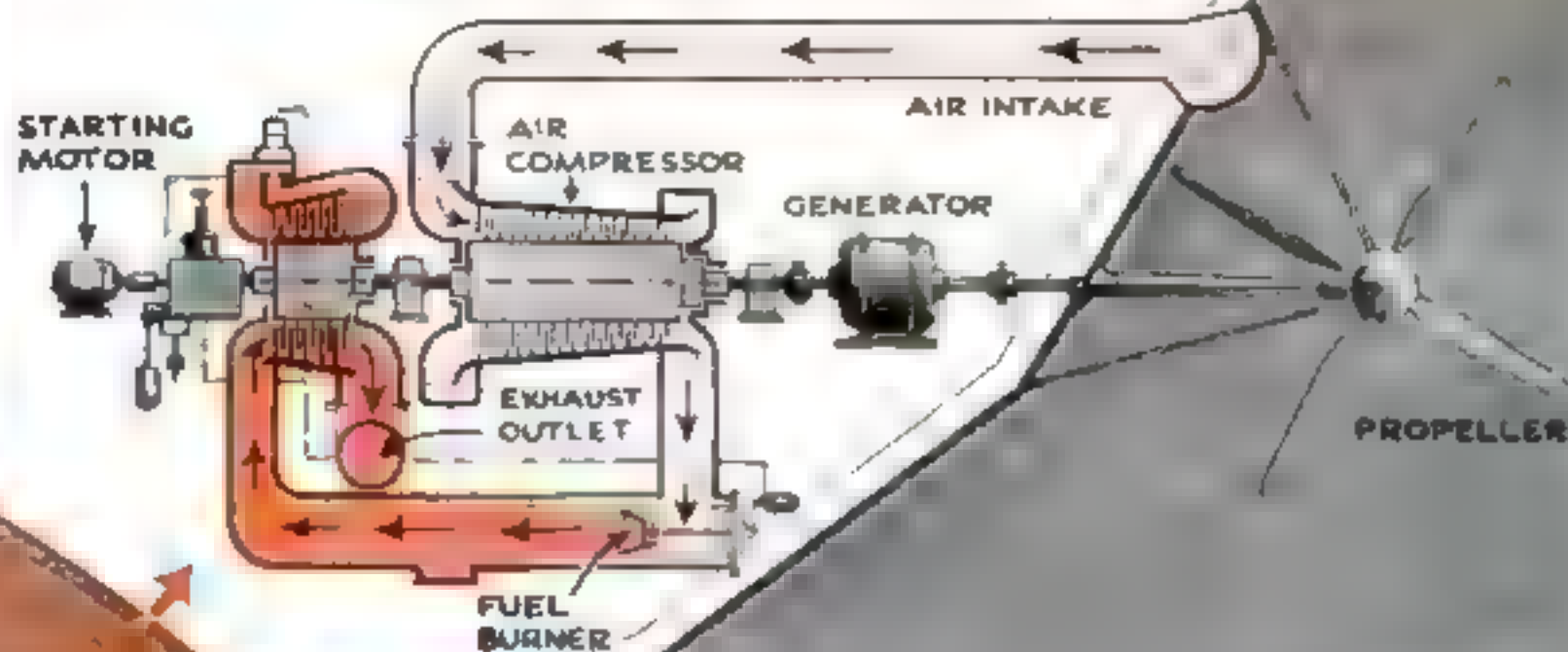


Dirigibles of the future will have spacious dining rooms and inclined windows for perfect observation. The lack of vibration will make eating a pleasure.

Real stateroom comfort aboard tomorrow's dirigibles promises delightful traveling. A sickness will be minimized through steadiness of the airship's flight.



Many American airmen predict the coming dirigibles will be driven by gas turbines, noted for their efficiency, power, lightness, and dependability.



WATER
CONDENSERS

FOUR
PROPELLERS
ON EACH SIDE

No radical changes in the exterior appearance of dirigibles are foreseen. Designers feel the postwar ship will closely resemble the familiar cigar-shaped craft. However, many internal refinements and structural improvements are certain. Technical developments will add to safety, economy, and efficiency of operation.

ment should have a payload of 100 passengers and 20,000 pounds of mail and express when inflated with helium."

American designers were the first to move the engines inboard to reduce drag, and to swivel the propellers for better control. Now it is suggested that both engines and propellers be placed in a central tunnel running the length of the ship, which would further reduce drag and improve control, and at the same time add a jet-propulsion effect. Also, it seems likely that tomorrow's airships will be using gas turbines for power, thus greatly increasing efficiency. These changes, experienced lighter-than-air authorities believe, could increase airship cruising speeds to as much as 125 miles an hour.

As for costs, it is worth noting that our whole military airship program up to 1941 cost less, for instance, than LaGuardia Field, New York City's airport. This included the

building of three rigid airships—the *Shenandoah*, the *Akron*, and the *Macon*—construction of two airship docks and bases, one on each coast, and five mooring masts, one on a ship for sea moorings. This airship program cost \$30,000,000. LaGuardia Field cost \$42,000,000.

Finally, America's monopoly on helium makes an American airship program a "natural." Add to that the fact that its shipment and storage are both complicated and expensive, which means it probably will remain here. Helium has nearly 93 percent as much lift as hydrogen, is an inert gas, and is foolproof and virtually accident-proof. Given capable handling, the weather information now available, and intelligent operation, American-built helium-filled airships would seem to demand a place in any international program of postwar commercial aviation.



NO DANGLING CORD will get in the way when this new cordless electric iron is used. A limited number will be made by the Eureka Vacuum Cleaner Company, of Detroit, Mich., under authorization from the WPB. The iron draws heat from a brief electric contact with a thermostat-controlled safety base. Exact temperatures for different materials can be obtained.

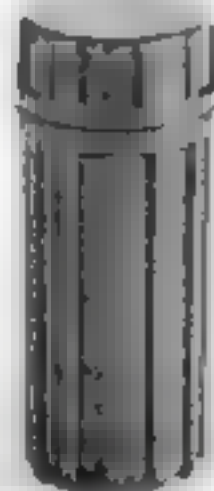


PLATENS ARE CLEANED with the same new liquid typewriter cleaner that clears type. The liquid, made by Mohawk Chemical Products, Inc., of Philadelphia, is said to revitalize the platen rubber.

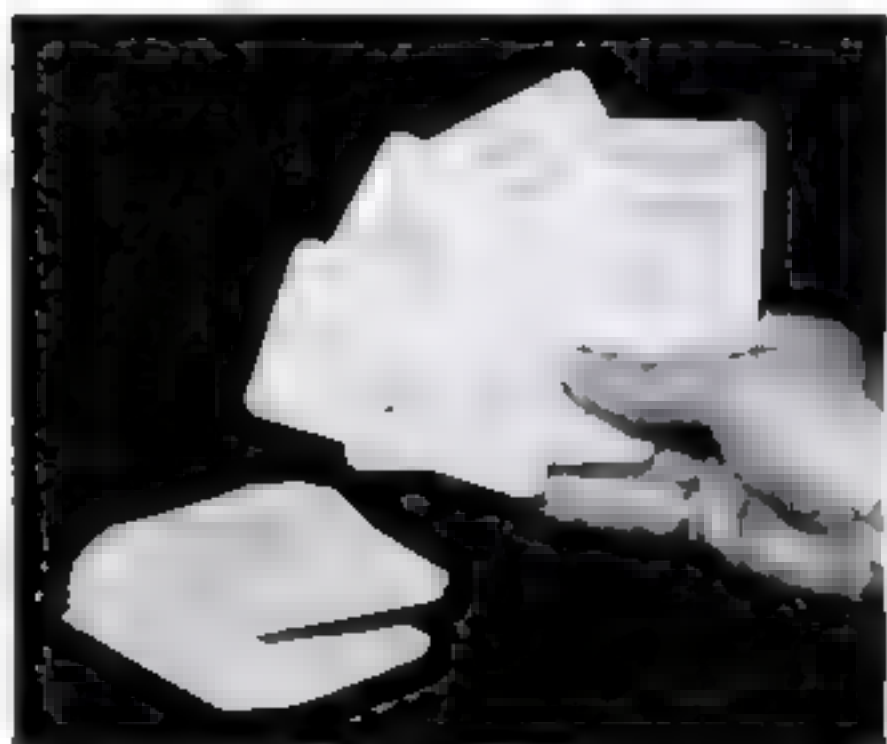
SPEECH BONERS have no place in this new card game, "Pronunciation," if you want to win. Each card bears words with and without their pronunciation. To get cards to fill books players must say the words correctly. Bertram B. Bellows developed and the Leister Game Co., Toledo, makes the game.

What's New in Modern Living

SURE FIRE even under difficult conditions is assured by this waterproof plastic matchbox developed for the armed forces but now available to civilians. The F. J. Kirk Molding Company, of Clinton, Mass., makes it. A flint provides sparks when the matches are exhausted.



WATERLESS HAND SOAP is a creamy preparation that is rubbed on the skin until it rolls off and takes the dirt with it—and no water is used. Hershel's Laboratories, Inc., of Parkman, Ohio, the maker, says it also leaves a protective film.





A REAL CORKER is this attractive little hat worn by film actress Maria Montez. It is made entirely of natural cork with the exception of a pressed-wood rose in front.

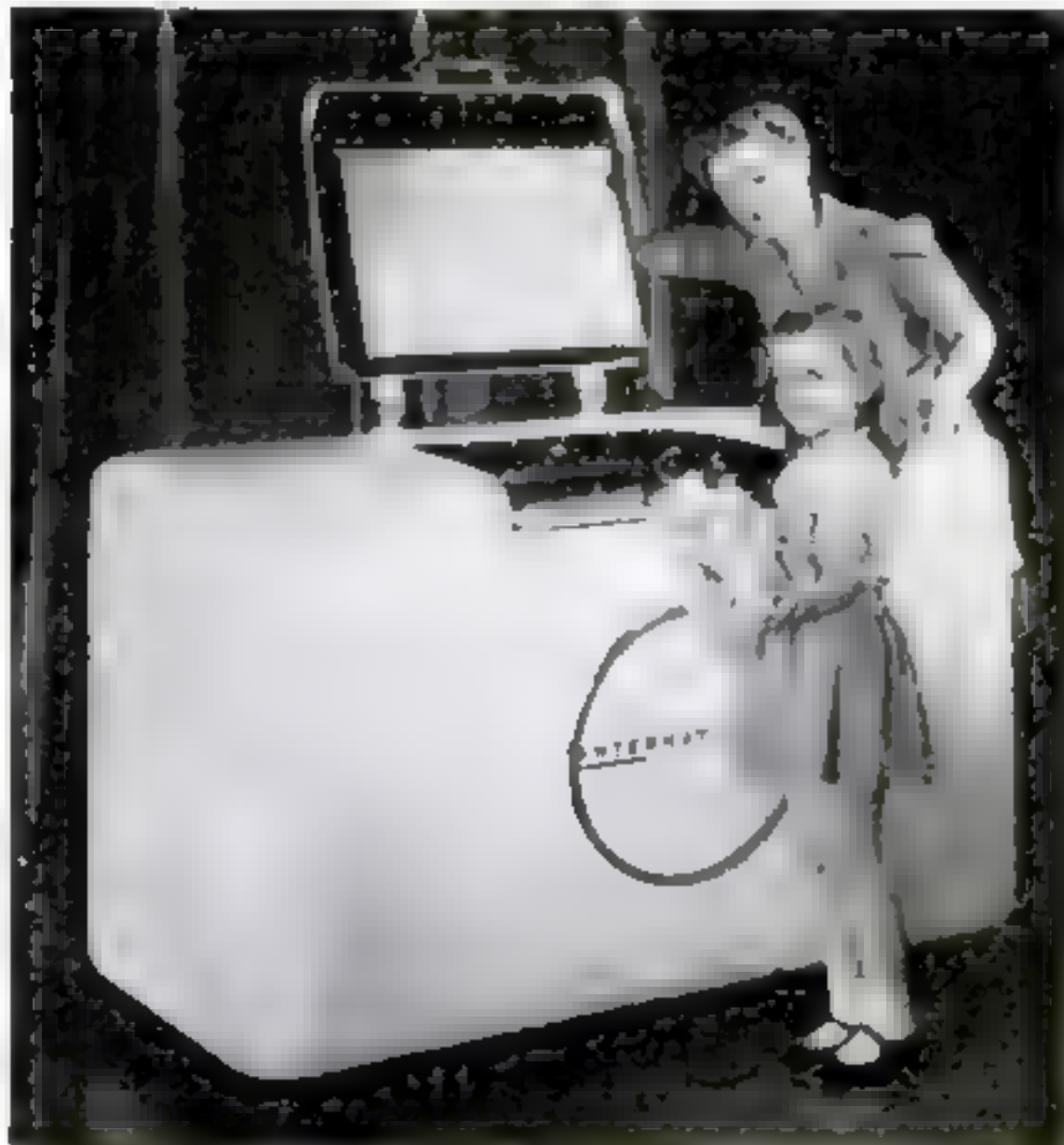


WOODEN SHOES are made for the U. S. Navy by Robert K. Girard in his Los Angeles factory. Sailors use them instead of leather shoes on sharp coral beaches in the Pacific.



THIS VICTORY HORSE of wood was one of 25,000 items utilizing only nonstrategic materials exhibited recently at a Los Angeles show. The horse is suspended from the four corner posts to swing freely. Woody from California, Los Angeles, makes it.

FREEZING AND STORAGE of perishable foods in the postwar era will be facilitated with this Zero Chest, designed by the International Harvester Company, of Chicago, Ill., for use in the home. It is electric powered.





Gus Solves a Rob-and-Run Case

By MARTIN BUNN

JOE CLARK hurried into the Model Garage shop. "There's a man in the office who wants his motor tuned up in a hurry," he told his partner Gus Wilson. "Can you handle it for him today?"

"Not a chance," Gus said flatly.

"This fellow looks like big money," Joe persisted. "His name's Jonas L. Whittman. He's from Boston, and he's staying down at the Park House while he's looking over some manufacturing plant he's thinking of buying. We've got to think of after the war, Gus, and he might turn into a good customer if we did him a favor now."

Gus grunted and waved a grease-blackened hand at the cars that crowded the shop floor. "Every one of those jobs belongs to someone who's a good customer now," he observed. "And every one of them needs something a lot more vital than a tune-up to keep rolling. You're a salesman, Joe. Sell your new friend the idea of waiting

his turn the same as everybody else these days. Let's see, now." He scratched his ear as he thought over the various jobs. "Wednesday's the best I can do," he decided. "Tell him if he has his car in here by noon I'll have it ready at five."

Just before noon on Wednesday, Stan, the grease monkey, came into the shop and said: "Party by the name of Whittman just left a bus outside."

"Drive it in," Gus directed. Stan did. Gus's eyes told him that it was an expensive five-year-old car that hadn't had good care. His ears told him that there wasn't anything seriously wrong with its straight-eight engine, but that it had been driven hard and probably far since its last overhaul.

He checked the engine, and then started to give it a good going over. When he got to the air cleaner he found it clogged with an unusual amount of sand. He spilled a little into his palm and rubbed the grains with a forefinger. In a wink he was 2,000

miles away from the Model Garage. Through the heat shimmer he could see far-off mountains gray-green with greasewood and purple with sagebrush. The sun was scorching the back of his neck; the hot, thin air of the high desert was in his nostrils . . .

Gus shook his head and laughed. "Doesn't a man ever get old enough for his feet to stop itching?" he asked himself.

Shortly before five o'clock two men came into the shop. One of them was stout and heavy-checked and had a manner in which authority was tempered by geniality. His companion had shifty eyes that looked like pale agates set close in a putty-colored face.

"I'm Mr. Whittman," boomed the heavy man. "My car ready?"

"All ready," Gus told him.

"Fine," Whittman said. "Much the matter with it?"

"Engine needed tuning," Gus said, "and your oil was dirty. I drained and flushed out the crankcase and refilled it."

"Fine," Whittman repeated. "Got to have the old car in good shape—I keep Blackie here busy driving me around these days, don't I, Blackie?" The man with the pale eyes nodded silently. "I'm from Boston," Whittman went on expansively, "looking over some small manufacturing plants with the idea of buying one of 'em."

"You've been in the Southwest recently—" Gus started pleasantly.

The pale-eyed man jumped backward as if he had stepped on a rattlesnake, and Gus saw his right hand glide into his coat pocket. Whittman glared at Gus. "What's that about the Southwest?" he rasped.

Gus laughed. "When I took off your air cleaner," he explained, "I found it pretty well loaded with sand."

"You're quite a detective, aren't you?" Whittman said poisonously. "But you figured wrong this time. I've never been west of Chicago, and neither has this car." He laughed suddenly, and all his geniality came flooding back. "That sand—now where could it have come from? . . . Why, of

course! Last month I was visiting my brother in New Hampshire—he's in the sand and gravel business. While his car was in the shop I let him use mine to get around to his plants. *That's* where it picked up the sand. Well, my friend, how much do I owe you?"

He paid his bill, forced an expensive cigar on Gus, and the silent Blackie drove him away. Gus shrugged. "It's none of my business," he told himself, "but no car in the East ever collects that much sand in the filter, and besides in the sand and gravel business they use a coarse sand."

TROOPER Jerry Corcoran, jaunty as usual, sat on Gus's workbench and lighted a cigarette. "Had any radiator jobs lately?" he asked. "Not for folks you know—a stranger with a leaky radiator?"

"The last one was months ago," Gus told him. "Why?"

"Read about that bank robbery up in Valleyfield yesterday?" Jerry inquired.

"I saw the morning paper," Gus said, "but Valleyfield is 70 miles upstate, so I didn't read the details. They shot a teller and ran over a kid on a bicycle making their getaway, didn't they?"

"That's right," Jerry replied. "When the thugs ran over that boy outside the bank they must have busted their radiator, because they left a trail of water in the street. And a farmer five miles out of town says that about the time of the stick-up a big black sedan with its radiator steaming like nobody's business passed his place doing over 70. That car answers the descriptions of the stick-up bus. We've checked all the garages and service stations up that way—but no dice. We're up a tall tree—and so are the G-men."

"How come the G-men are in on it?" Gus wanted to know.

"They can cut in on any national-bank job," Jerry said. "But there's something else. The G-men think this job was done by a stick-up mob that headed East a couple

A big black sedan, its radiator steaming like nobody's business, passed his farm doing over 70



of months ago after pulling several big bank holdups in the Southwest."

Something clicked in Gus's brain. "Holy cats!" he muttered. "The Southwest!"

His eyes intent, Jerry edged forward. "What cooks?" he demanded.

Gus thought for a long minute. Then he said: "Maybe there's nothing in this, but just a week ago . . ."

He told Jerry about the desert sand he had found in the filter of Whittman's car and how Whittman had explained it.

When he had finished, Jerry slid off the bench and straightened his belt. "I'm going downtown to see the captain," he said.

Two hours later he came back. "It fits—part way, anyhow," he reported. "The only member of the Desert Rat Gang that there's a description of is the man who 'cased' their jobs and getaways. He worked ahead of the gang, posing as a financial big shot looking for investment opportunities. Whittman fits his description. He and the guy they call Blackie are still at the Park House. So is another fellow who checked in the same day they did.

"We took the trouble to make a telephone call to every plant in this district, but not one has ever heard of Whittman. The Boston police are checking, but we haven't heard from them yet. We haven't got enough to make a pinch, but we're giving all three a grilling at the Park House. Whittman's car is in the hotel garage. We haven't got any legal right to touch it, but the captain wants you to go with me and see if there are any indications of radiator damage."

After he had looked over every square inch of the sedan's front end, Gus shook his head. The only scratches and dents on it were to be expected on a five-year-old car. "If I could lift the hood—" Gus mused.

"You can't!" Jerry snapped. "No touch!"

Gus had an idea. "Just what happened when they hit the bicycle?" he asked.

"The boy was knocked clear," Jerry told him, "but his bike was bent like a pretzel."

Gus nodded. "Give me your flashlight."

Jerry handed it over, and Gus crawled under the car. After half a minute he backed out. "The radiator drain valve has been opened and closed recently," he said. "There isn't any dust on it, and there are fresh plier marks on the shutoff lever, and besides, there are new scrape marks on the oil pan. What happened is that, when they ran over the bike, the drain valve got snagged in the handlebars or something and was jerked open. When they noticed that the radiator was steaming, they stopped somewhere, closed the drain cock, and filled the radiator."

"Come on," Jerry said.

They met the State Police captain in the lobby. After he had listened to Gus's story, he rubbed his square chin. "Well, Mr. Wilson," he said, "that isn't evidence that would stand up in court, but maybe it'll worry Whittman and his pals. We'll go up, and I'll question you before them."

There were several State troopers, the town chief of police, and three G-men in the room. When Gus went in, Whittman smiled sneeringly, Blackie glared, and the third prisoner, a husky fellow Gus hadn't seen before, eyed him cagily.

The captain asked his questions, and Gus answered them. Whittman laughed. "You're either lying or you're nuts," he told Gus. "That radiator hasn't been touched in months, you noney whistle-stop jerk!"

Gus's voice didn't show that he was mad. "I suppose," he said casually, "that your radiator hasn't boiled over or your engine run hot for months, either."

Whittman snapped: "No, it hasn't!"

"That being so," Gus said, "why not give me permission to examine your engine?"

Blackie shook his head, but Whittman overruled the unspoken advice. "All right—go ahead and play detective," he sneered.

Down in the Park House garage, Gus jacked up the front end of Whittman's car, held a piece of cheesecloth under the crankcase drain, and began straining oil through it into a pail. After a moment he screwed in the plug, examined the cheesecloth, and showed it to Jerry.

"What's that dark stuff?" the trooper asked. "Coffee grounds?"

"It does look like fine coffee grounds," Gus said, "but it is carbon deposit—particles of oil drops that have been 'cracked' by coming into contact with the underside of extremely hot pistons. I filled the crankcase with clean oil a week ago. These carbon particles in it prove that since then the engine has been badly overheated. Send the oil in the crankcase to a laboratory for analysis, and you'll get evidence that will stand up in court."

A FEW days later Jerry came into Gus's shop whistling. "Your coffee grounds turned the trick," he said. "When the laboratory report came back, the boss showed it to those three beauties separately. Blackie lost his nerve and squealed. They're part of the Desert Rat Gang, and they did the Valleyfield job. Three others got away in another car with the take—over 20 grand—but Blackie told the G-men where they can pick them up . . . The captain wants to know when you're going to join the force."

"I'm not," Gus said. "The first time they put me on a case that didn't have an automobile in it, I'd lose my job."



As these steps in assembly suggest, this compactly folded compartment can be installed in short order



HINGED PLYWOOD PANELS ADD COMFORT FOR EXTRA PASSENGERS

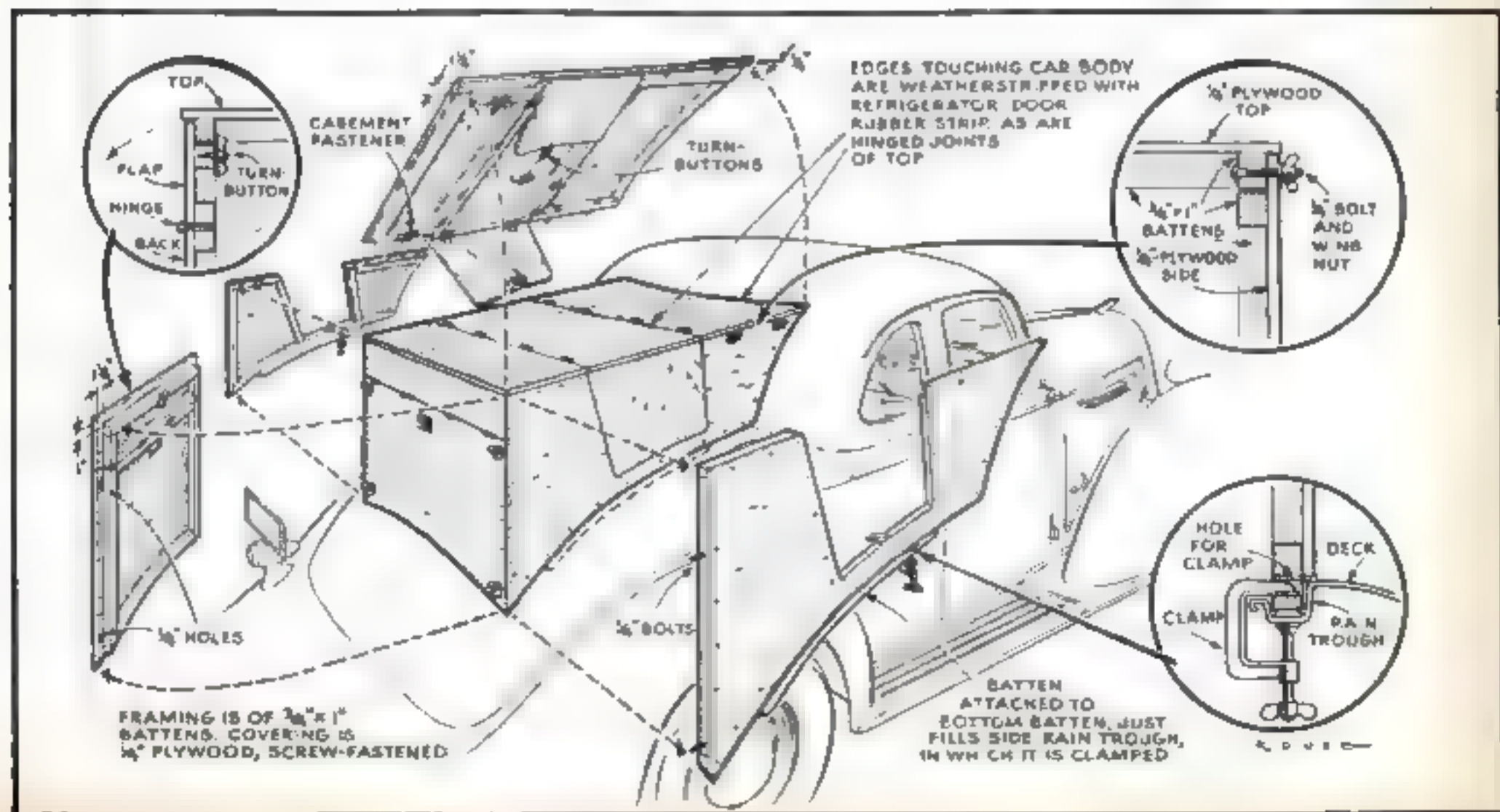
Rumble-Seat Enclosure

EXTRA weatherproof space is provided for a coupe with this rumble-seat enclosure. Once built to suit your car, it can be put into place or removed in three to five minutes, and when not in use it stores inside the closed rumble seat. If the rear window opens and the car has a heater, you can keep the compartment warm in winter.

The enclosure consists of four sections—two sides, the back, and the top, all made of $\frac{1}{4}$ " plywood attached with screws to $\frac{1}{2}$ " x 1" battens. The top hinges at two places, the rear pieces folding forward over the front piece. This sectional top not only facilitates access to the seat but provides a variable degree of exposure above on sunny

days. The side flaps, hinged to the top batten, swing up and in, and turn buttons above hold them open. If you wish, glass can be installed in these flaps for a side view when they are closed.

The contoured edges touching the car are weatherstripped with refrigerator-door rubber, as are the hinged joints of the top. A batten on the lower edge of each sidepiece fits snugly into the rain trough, and clamps placed through holes in these battens and under the troughs hold the entire unit in place. A coat of linseed oil cut with turpentine serves as an undercoat for the plywood. Finish off the unit with paint matching the car—WILLARD JARDINE.



From 3½ oz. of oil drawn from your engine the car doctors can tell you what's wrong.

FABER Laboratories

NEUTRAL - to brands and products.
IMPARTIAL - to buyers and sellers.
UNBIASED - opinions and analyses.

TEST NO.		FUEL		WATER		OIL		TEMP.		PRESSURE		TIME		ANALYST		
DATE	NO.	TYPE	RATE	TEMP.	PRESS.	TEMP.	PRESS.	TEMP.	PRESS.	TEMP.	PRESS.	TEMP.	PRESS.	NAME	INITIALS	
100	1.4	2.7	2.4	Slight Ring & Wall	X	Trace	X	Slight	X	Normal	30	AVER.	7.1	Drain Box	11/1/44	
Ring sticking from local piston heat is indicated. Check timing, valves, cooling; then purge engine, as the sludge index indicates engine deposition.																
SLUDGE INDEX: 4.7																
779	14.0	0.4	1.6	X	X	X	X	High	X	Cool	30	Slight Rings	7.0	Drain Box	11/1/44	
Incomplete combustion has been occurring and the combustion adjustment should be checked; ignition, stock choke, carburetion. Water has also been running too cool. Conditions such as this cause clogging of oil slots in oil rings. Drain now, purge, and change filter. The next test will show if improved.																
SLUDGE INDEX: 13.2																
25272	7.2	1.0	2.8	X	X	X	X	X	X	Normal	30	AVER.	7.0	61440	12/4/44	
The solids are showing a tendency to accumulate; however, their nature is such that filter pack servicing should correct this. Change pack, then test as above indicated for verification.																
SLUDGE INDEX: 3.0																
730	6.3	4.3	4.0	Trace	X	15.0% Emulsion	X	X	X	Trace Oil	Normal	30	AVER.	7.7	7752 Box	11/1/44
The solids in combination with the emulsion from the water leak have thickened the original S.A.E. #30 oil to the equivalent of an S.A.E. #50; remove oil lines and screen stoppage. Tighten head, then drain, purge and change filter.																
SLUDGE INDEX: 12.0																
25372	1.3	0.6	1.2	REPAIR	X	Trace	X	X	X	Trace Oil	Normal	40	AVER.	7.0	7111 Box	11/1/44
Extreme bearing wear has appeared since last test and the engine has been operating too warm. Also, fire sand appears. Drain and flush crankcase. Check clevises and breathers. Keep this motor under close observation until the next test indicates if you should be dropped. The condition of the oil itself is good and would not cause the wear as Sludge Index is also low.																
SLUDGE INDEX: 1.0																
247	5.8	0.3	1.2	X	X	X	X	X	X	Normal	40	AVER.		6622	12/1/44	
The condition of the oil is excellent with no mechanical change indicated since last test.																
SLUDGE INDEX: 0.6																

IF THIS FORM IS NOT RETURNED TO FACTORY

able story, and it points to even greater diagnostic wonders that may be in store for car owners. For example, the first line of the chart on the facing page suggests how hidden defects may be spotted before they have a chance to make trouble. This sticking piston ring might not otherwise have been detected without a major overhaul, and yet neglect of the condition could have done serious damage.

The Army has found that oil analysis pays, and so have civilian operators of truck fleets. They not only have discovered how to nip trouble in the bud, but they have also learned a lot about engine performance under all sorts of operating conditions. Periodic reports on oil samples taken from their working engines enable them to *know* they are doing the right things to prevent trouble, not just to hope for the best because they follow a formula that has proved successful under some operating conditions.

What the Army and motor-fleet operators find profitable applies equally to the individual motorist, and it may be especially valuable after the war when driving restrictions are lifted and the average car is again worked hard. Not that the driver can make his own analysis; there are com-

mercial laboratories set up to do that for him. But he can take a sample from his engine oil, or have it done at a filling station, and then act on the report he gets a few days after he has mailed the sample in.

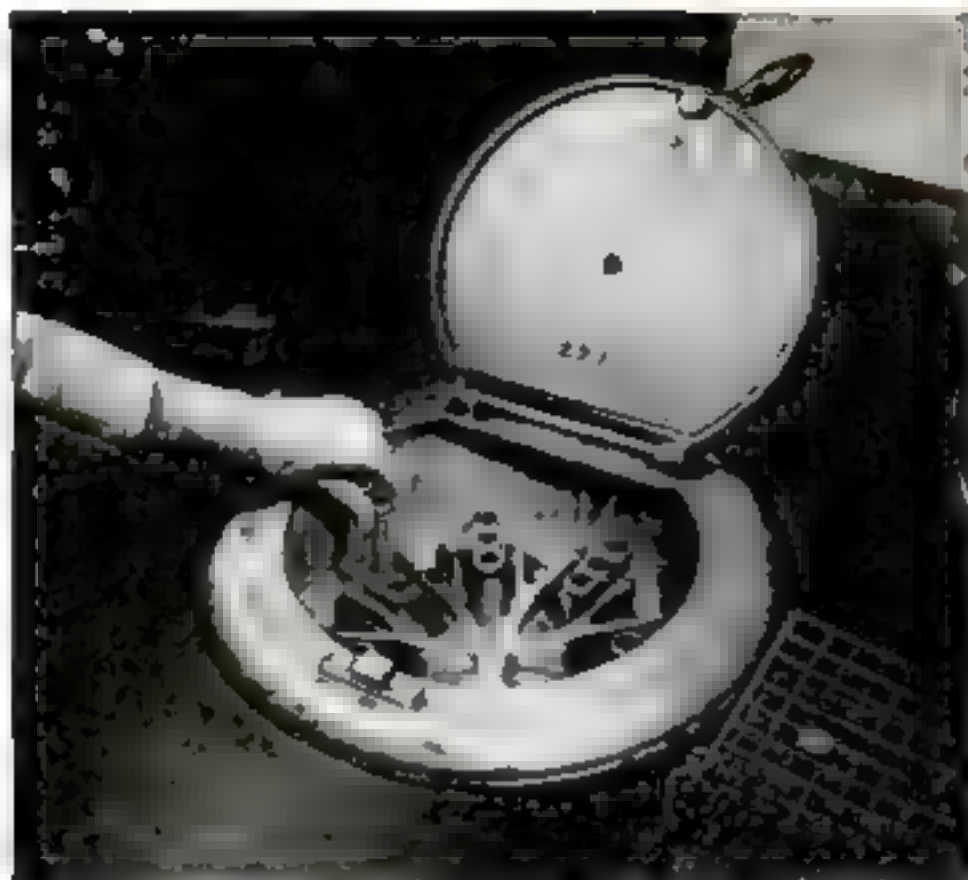
Even if the private driver were equipped to make the analysis, it would do him little good, for he would have no comparative data to help him draw conclusions. Faber Laboratories, of New York, for instance, has made more than a million tests on samples taken from cars operating in all parts of the country, including analysis for the Army, and from these tests has been able to set up normal standards for each section.

These standards indicate incidentally that some of the old ones might well go by the board. The selfsame car using the selfsame motor oil may give an entirely different performance in different parts of the country under different climatic conditions, and performance may vary even in near-by sections because of diverse topography. San Francisco with its numerous steep hills has been found to punish oil more severely than any other place in the country, and it is thought that this is because of extreme fuel dilution caused by descending these

OIL ANALYSIS NOW NIPS TROUBLE BEFORE IT GETS A START

This and following photos by ROBERT F. SMITH at Faber Laboratories.





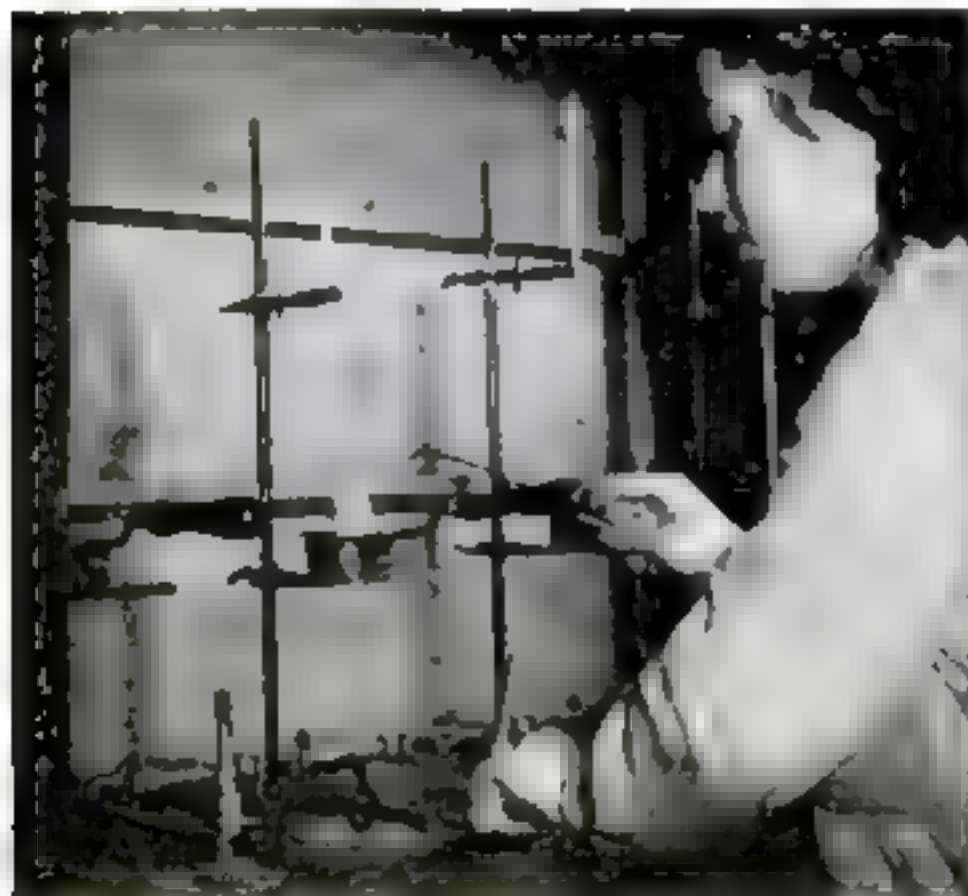
When the sample of oil is received at the testing laboratory it is put in a centrifuge, a whirling machine that separates the solids from the fluid.

Heating a little of the sample and playing a gas flame over it shows the temperature at which it ignites. Fuel dilution causes a low flash point.



Before centrifuging, different chemicals are added to two portions of the sample. Results of the test show both present and potential sludge formation.

Viscosity, or internal resistance of the oil to free flowing, is measured in a special machine. Tars and gums in the oil tend to make it viscid.



hills against compression. On the other hand, Los Angeles, less than 500 miles away, is one of the best cities for car operation. The comparative flatness of the land should make oil last nearly twice as long, other conditions being the same, as it would in a car driven around San Francisco.

Here are some of the things that can be expected in performance in the four general climates we have in this country. In cold, dry areas engine trouble can most often be laid to abnormal fuel dilution, water emulsion and sludge in the crankcase, and residual formations. Where it is cold and damp, the common causes of trouble are water emulsion in the oil, residual formations, poor oil filtration, and engine wear. Abra-



sive dust and sand entering from outside cause engine wear in warm, dry areas, and excessive engine and oil temperatures are also likely. Warm, damp areas are usually best for performance, but if the weather doesn't stay warm and damp there is danger of dust when it is dry, and of the usual cold, damp conditions on cool days.

When you send your oil sample in, the analysts know what to expect of a car in your neighborhood, and they measure the results of their tests by that yardstick. The sample itself is best obtained with a suction gun, such as the one shown in the hands of the mechanic in the photo on page 142. For correct analysis, there is a definite sampling procedure that must be followed.

The engine should be warm when the sample is taken. Remove the oil dip stick and put the long stem of the suction gun in the hole, pushing it down until it touches bottom. Then pull the handle all the way up, push it down again to expel the drawn-in oil and to clean out remains from the last test, and pull it up a second time. This second gun load is what you want for your sample. Empty it into the container furnished by the laboratory, fill out the data sheet supplied with it, pack both in the mailing carton provided, stamp the package, and send it on. The laboratory will do the rest. But don't forget to wipe the dip stick before you put it back, or you may wind up with dirt in your oil that doesn't show in the test.

At the laboratory the sample will go through a whole series of tests. These are designed to show the condition of the oil, the amount of dilution, the presence of water emulsions, and signs of soot, carbon, metallic particles, and the like. They also show what mechanical defects, if any, caused their appearance in the oil.

Solids are separated from the oil sample first. At Faber Laboratories this is done in a centrifuge. All foreign matter is carefully checked and correlated, and when metal particles are found they are examined to determine the type of metal, the source, and their importance. Minute pieces may come from the cylinder walls because of ring scuffing, from timing gears, from bearings, or from the camshaft.

Tests on the oil itself include heating a sample and exposing it to a gas flame to determine how hot it must be before its gases ignite. Gasoline in the oil thins it out and of course reduces this flash-point temperature. Abnormal gasoline dilution is also measured by distillation. Viscosity is determined by special apparatus.

The result is that the driver gets a full report on fuel dilution, solids, viscosity, metal, water, gum and tar residues, fuel soot, free carbon, dirt and sand, and approximate crankcase operating temperature. More important, he gets a full report also on what caused any undue oil deterioration or presence of foreign matter, along with recommendations for correcting the fault before it causes mechanical failure.

Water emulsions in the crankcase, for instance, result from

leaks usually around a loose cylinder-head gasket or through a cracked block or cylinder head. Free carbon, frequently called coffee grounds because of the resemblance, comes often from the underside of the piston heads and indicates high local piston heat that "cracks" particles of oil. An abnormal amount of free carbon calls for an immediate check of the timing, valves, and cooling system.

Certain conditions of the oil show whether the operating temperature of the engine is within the normal range. Overheating causes excessive ring and cylinder-wall wear, while cold running causes oil dilution.

Sludge is formed by a mixture of decomposed and oxidized oil and fuel products. It may result from inferior oil, improper engine adjustments, or faulty operation. Tars, gums, water, or a combination of the three may be the base. Some sludge may clog the oil filters and screens and result in a bearing failure, or it may block oil holes and damage cylinder walls.

The analysis thus not only tells you what condition your oil is in, but it also points out why it is in that condition and what should be done about it. Periodic reports reveal whether the corrective steps have worked, and all in all they keep you informed on what's going on inside when you step on the accelerator. There is little more you could wish for, unless it is that your car learn to talk and tell you where it hurts.

Oil dilution due to improper fuel combustion is determined by a process of distilling. Crankcase emulsions may come from leaks caused by a loose gasket or a cracked block or cylinder head.





COLOR-CHANGING PAINT signaled cylinder temperatures in German test engines used to check motor fuels, according to a German technical publication. Instead of using a test cylinder studded with numerous thermometers or thermocouples, technicians sprayed one as at the left with a temperature-sensitive paint. This changed color at various well-defined temperature ranges. The cylinder, at first of uniform color, turned many-hued as it heated up in operation. By studying the shift of border lines between the several color zones, Nazi engineers could compare the operating temperatures of various portions of the cylinder to check the combustion characteristics of aviation and other motor fuels.

STARTING WAR MACHINES is a specialty at the Eclipse Machine Division of Bendix Aviation Corporation. Shown at right are seven of 500 standard and special starters. That at the upper left in the photo is used in tanks, the next is for PT boats, and that at right in the lower row is for starting generator plants. The others are typical models for jeeps and other military vehicles having internal-combustion engines.

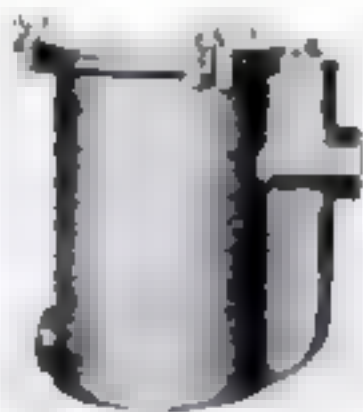
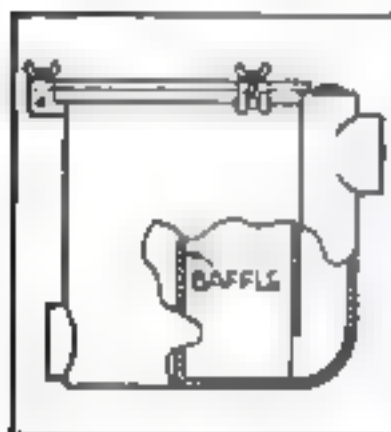
SELENIUM-TREATED OIL is shown by tests at the Battelle Institute, of Columbus, Ohio, to support increased bearing pressures and to resist the tendency of motor oil to oxidize and form sludge and gummy resins. The nonmetallic chemical, a by-product of copper mining, is used in photoelectric equipment, talking movies, glass coloring, and various other industries.

PART TRUCK, PART TRAIN, this hybrid machine is a locomotive built from the junked cab, engine, and chassis of a truck. It is equipped with flanged train wheels and a discarded cowcatcher so it can ride the rails, and is powerful enough to haul a loaded freight car. Machinist Frank P. Hatfield, of Harriman, Tenn., used his ingenuity in putting it together to pull tank and gondola cars on the tracks at the naval air station at Houma, La.



OF INTEREST TO HOME OWNERS

GREASE SALVAGE as well as prevention of clogged drains is possible with an interceptor now made in a small size for household sinks. The unit is built on the same lines as a larger type long in use in restaurants and hotels. It is installed under the sink where its baffle arrangement stops the flow of grease down the drain. A removable lid held by wing nuts facilitates cleaning. The piece is built of cast iron and is finished in gray. Wade Manufacturing Co., of Elgin, Ill., is the maker.



WINDOWS THAT CLOSE automatically when it rains may be seen in many postwar homes. The test device shown below is set up on a casement window, but it can also be used on double-hung windows, and its motor can be concealed. It is an adaptation by Lear Avia, Inc., of Piqua, Ohio, of actuators controlling flaps, tabs, landing gear, and the like on planes. Moisture closes the switch that starts the motor, which may control one or more windows.



AIR IS DRIED in basements, clothes closets, pantries, and the like by a newly designed dehumidifier with features that step up efficiency by exposing more absorbent surfaces to the moist air. Among these are terraced liquid receptacles that permit re-use of the chemical after it melts. Each unit holds 10 lb. of chemical cubes and will service 800 to 1,000 cu. ft. of room space. The manufacturer is the General Air Conditioning Co., of Cincinnati.



GIANT TUBES for fluorescent lighting are planned for manufacture by the Westinghouse Lamp Division at Bloomfield, N. J., as a postwar product, or earlier if war conditions permit. These long, slender tubes are designed for use in homes as well as in industrial and business establishments where a long, narrow line of horizontal or vertical light is desired. The slim "bean pole" style shown at the left is 8' in length. It is the longest of four new extra-length lamps in the Westinghouse line.

SOIL CULTIVATION with a push-type machine that is operated like a lawnmower should make work easier for the Victory gardener. The cultivator has five sharpened steel prongs that are adjustable for depth and also for working width. Attachments also available are a combination tool for furrowing and hilling and a weed sweep that cuts off weeds below the surface. Charles M. Kearns, of Beavertown, Pa., is the manufacturer.

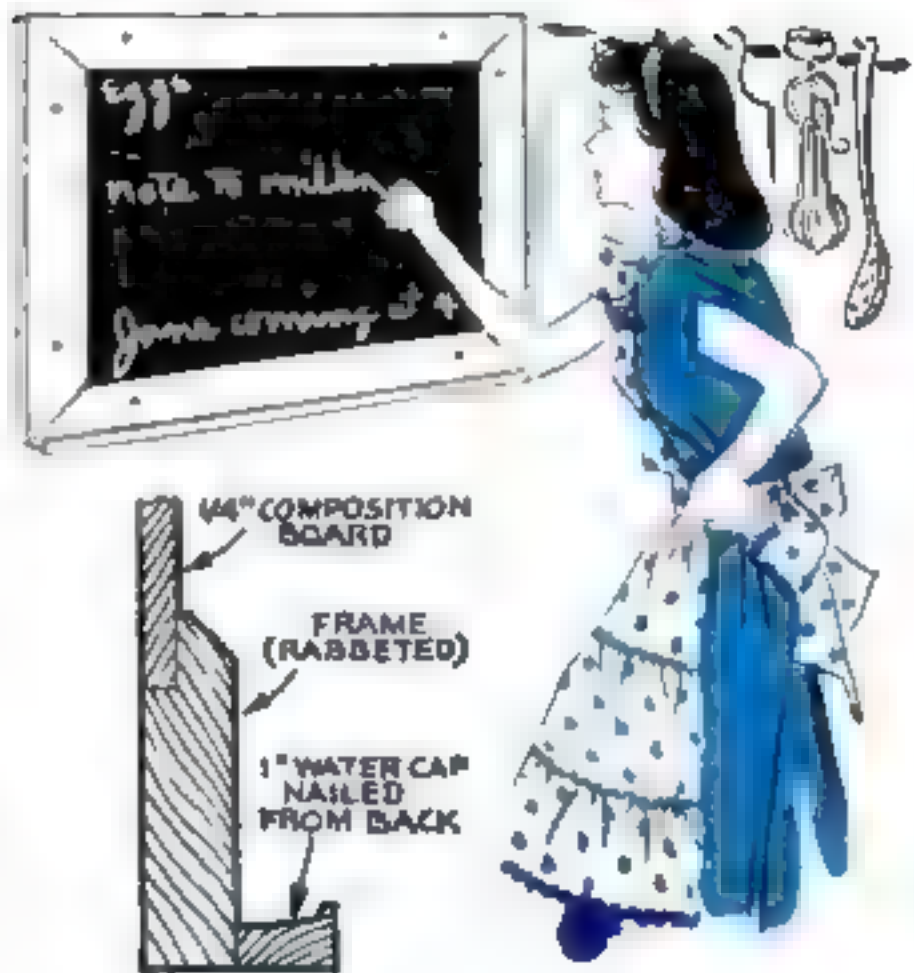


Make a Note to Make Yourself A Useful Kitchen Blackboard

EVERY member of the family will probably find occasion from time to time to scribble a reminder or a message on this kitchen blackboard, although the busy housewife, of course, will use it most frequently.

A satisfactory blackboard can be made at home. The most important item is a piece of $\frac{1}{4}$ " black composition board. You may be able to find this in the scrap bin at your local lumber yard. If black composition board is not available, ordinary hard-surface composition board can be used by giving it two coats of the prepared blackboard paint that is available commercially. You should also obtain some 4" soft pine for the frame and a length of 1" water cap or other molding.

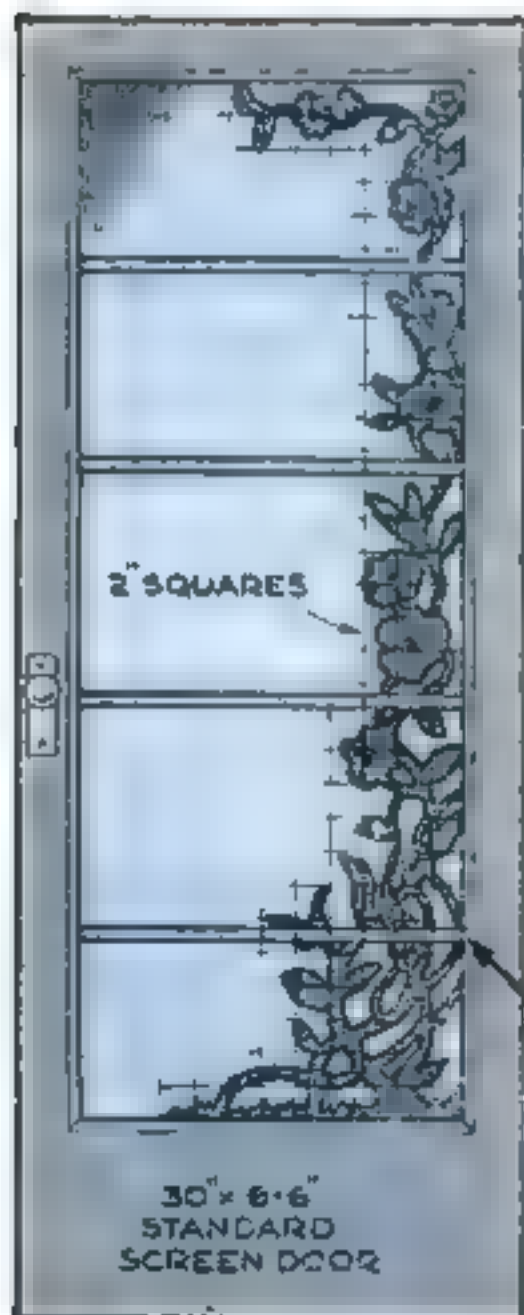
The blackboard can be any size that fits into the space selected for it, but it is important that the screws holding the sides of the frame to the wall be driven into studs. These are usually 16" apart from center to center. Thus, the sides would be 32" between centers in a frame having an over-all length of 86". A good correspond-



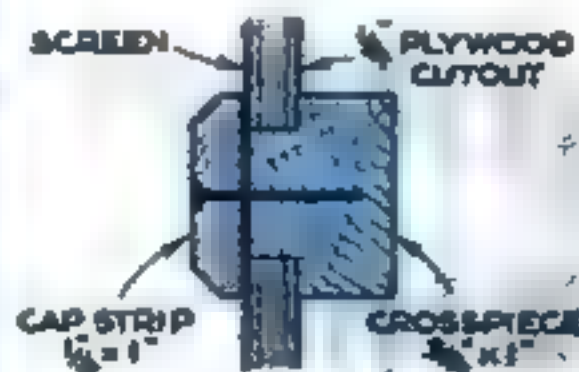
ing depth in that case would be around 28".

The soft wood of the blackboard frame is an additional place for desirable memorandums on paper if a supply of thumbtacks is kept at hand.—NORBERT ENGELS.

Vine Silhouette Brightens Up Screen Door



SILHOUETTE panels in a vine-and-flower pattern cut with a scroll saw in sections and installed between cross members will spruce up a standard screen door. The crosspieces should be mortised into the side frames and rabbeted, as shown in the drawing, to hold the silhouettes firmly against the screen. A wide cap strip clamps the pieces. For the silhouettes, either $\frac{1}{4}$ " waterproof plywood or thinner hard pressed wood is suitable. Vine and flowers are best painted alike in a lighter tone than the frame. Bright colors might be appropriate.—HI SIBLEY.



Ribbon Bookmark Fits into Binding

RIBBON bookmarks usually are attached firmly to a volume, but the one shown above can be used in one book after another. It consists of a 10" ribbon with one end glued between two strips of cardboard which can be inserted in the back of the binding, as indicated, leaving the ribbon free to go between the desired pages.—FRANK SHORE.



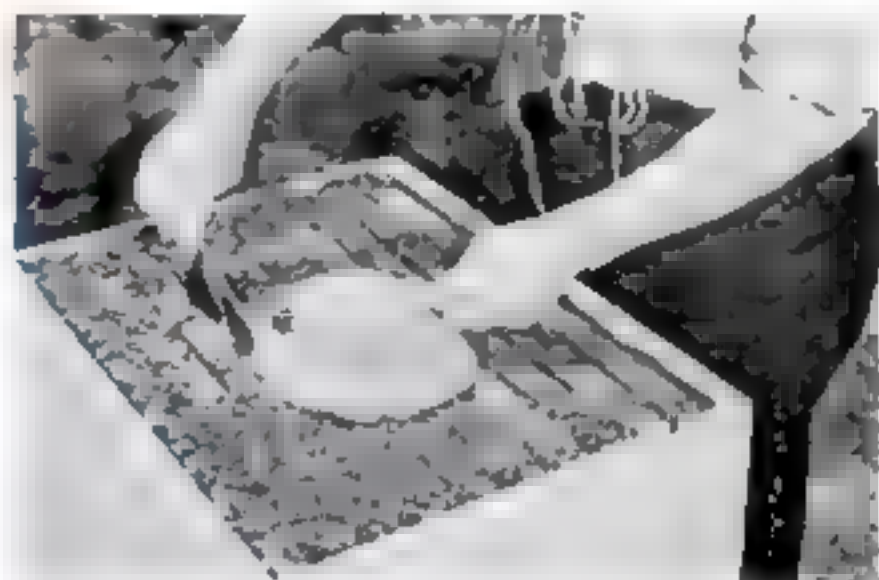
Pollen Traps in Autumn Feed Spring Bees



HERALDING a new era in the beekeeping industry is a pollen supplement that helps build up strong colonies for the honey harvest at times of critical shortages of natural pollen. This new food for rearing baby bees consists of natural pollen and a soybean flour molded together in cakes with sugar syrup. Dr. C. L. Farrar, of the U. S. Bee Culture Laboratory at Madison, Wis., has found that a good proportion is one part pollen to three of expeller-processed soybean flour.

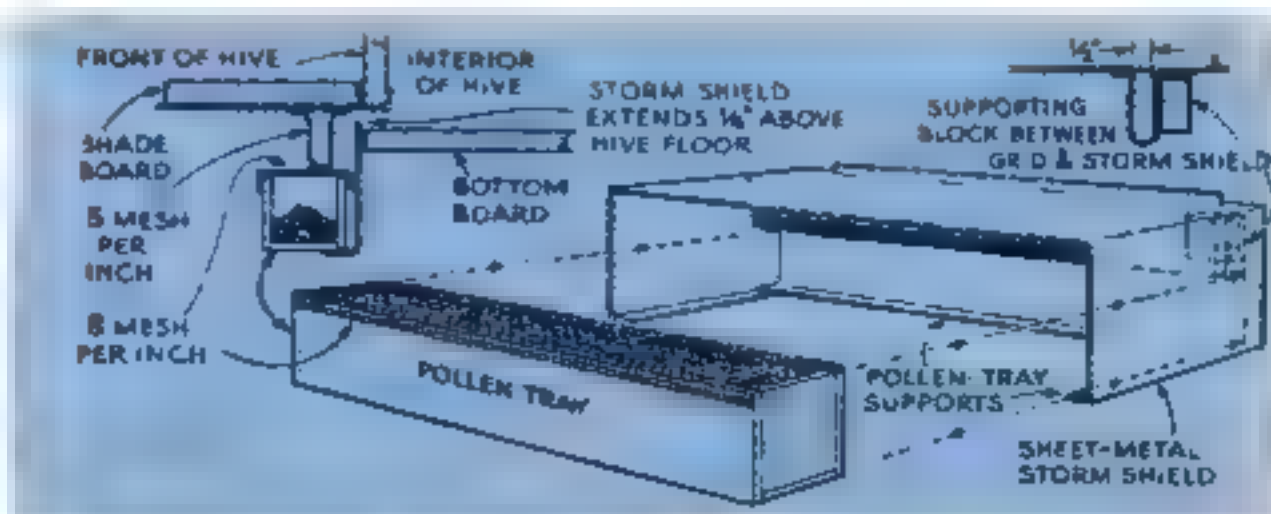
Natural pollen is obtained by placing a trap across a hive entrance, as in the photo at the left above. The trap's main feature is a double grid of 5-mesh hardware cloth through which the bees must pass to enter the hive. Pollen pellets brushed off their legs fall into a removable tray, covered with a 7-mesh or 8-mesh hardware cloth to exclude the bees. A storm shield made of sheet metal guards the grid and tray from rain and bars entrance except through the grid.

The grid, which must fit snugly down against the tray covering, is made by folding the piece of 5-mesh hardware cloth so as to form a "U" about 2" deep with the two sides spaced $\frac{1}{2}$ " apart. Turn



the cut edges at right angles to permit soldering to the storm shield. The shield extends about 8" in front of the hive, and its underedges are turned in to support the pollen tray. A cut in the top of the shield allows a right-angle flange to fit inside the front of the hive body. The shield's back should extend $\frac{1}{4}$ " above the hive floor to exclude water from the tray. Corners between the grid and the back of the shield are filled with small wooden support blocks. These reinforce the ends of the grid, permit the use of a pollen tray short enough to be removed easily, and prevent entering of the bees at that point. The pollen tray is made of wood and $\frac{1}{2}$ " composition board with a cross section of about 8" by 8". A shade board keeps the top of the shield from getting too hot in direct sunlight.

Such a trap placed at the entrance of a strong colony in the fall will collect enough pollen to make cakes for feeding 50 colonies in the late winter and early spring during the critical brood-rearing period. Pollen should be emptied from the trap every two or three days and spread out $\frac{1}{2}$ " or $\frac{3}{4}$ " deep for drying. To exclude moths, store the pollen in glass or metal containers after it is dry enough not to cake. About March 10 to March 20 in areas where the main honey flow begins in June, a soybean-pollen cake, flattened to a thickness of $\frac{1}{2}$ ", should be placed over the center of the bee cluster, as at right above.—CLARENCE TONTZ.



CHEMICAL MARVELS TAKE

From DDT and Other War Developments, Our Homes Get Promise of Such

By ARTHUR BARTLETT

PICTURE of an American home a few years after the war:

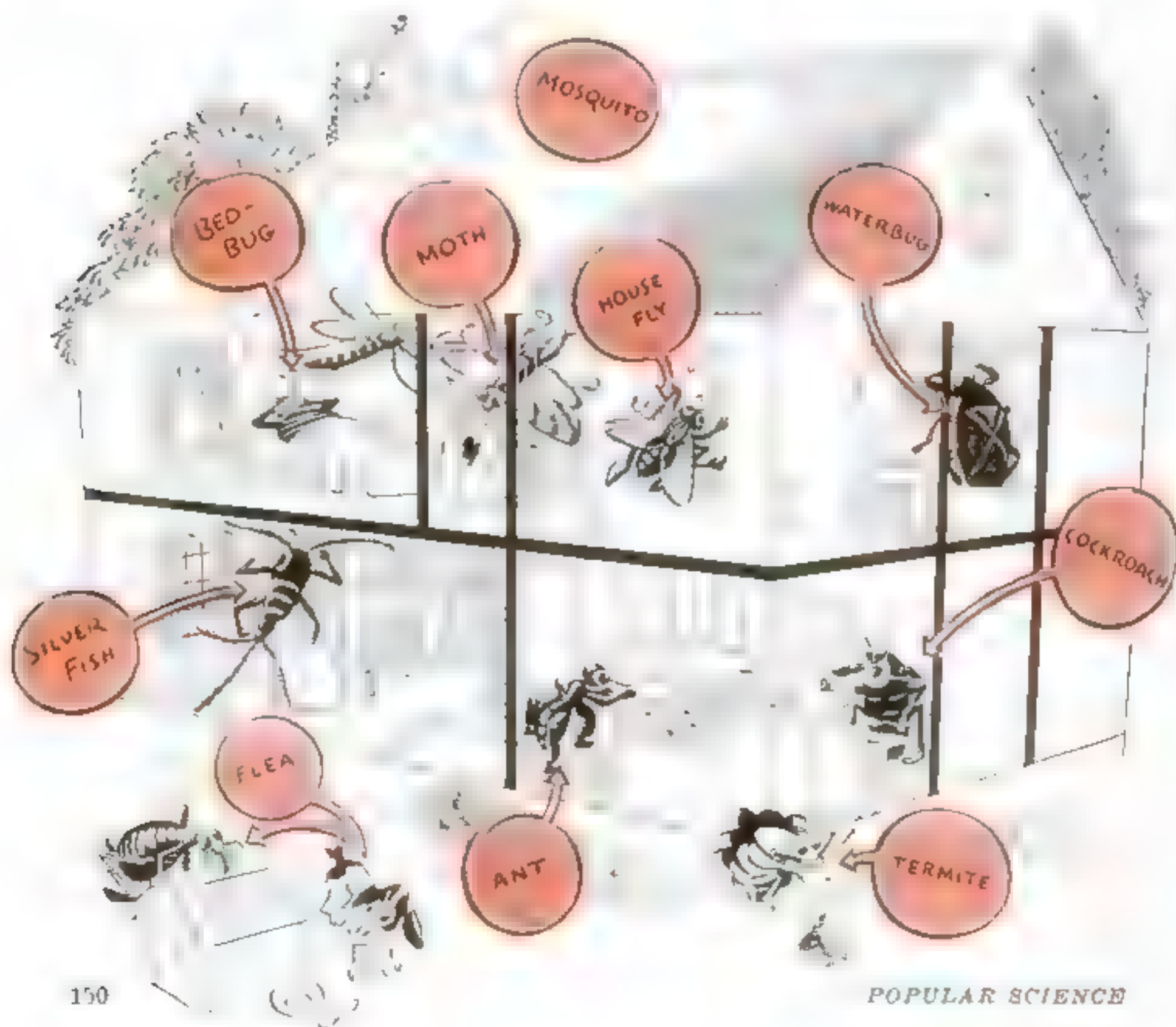
Flies, mosquitoes, moths, and other insects die as fast as they sneak in. Even microbes are licked before they have time to get in their dirty work. Clothes and household fabrics wear longer and keep their shape with a minimum of ironing-board attention. Fire has little chance to get a start. Furniture keeps on looking new almost indefinitely. Doors, windows, and bureau drawers never stick. Weeds in the lawn shrivel up and die, and poison ivy doesn't bother the children. Even old Rover, the faithful family dog, shares the blessings of the day to come; fleas and ticks no longer

make his life one long session of scratching

It may sound like just a sweet dream, but it will all be possible, and more like it, too, when Mr. and Mrs. Postwar American and their family begin to benefit by what the chemists have been up to during these recent years. The needs of the armed forces have been damming the flow of new and wonderful things from the laboratory to the home. When the priority dam breaks, a whole flood of boons to modern living will head toward the American home.

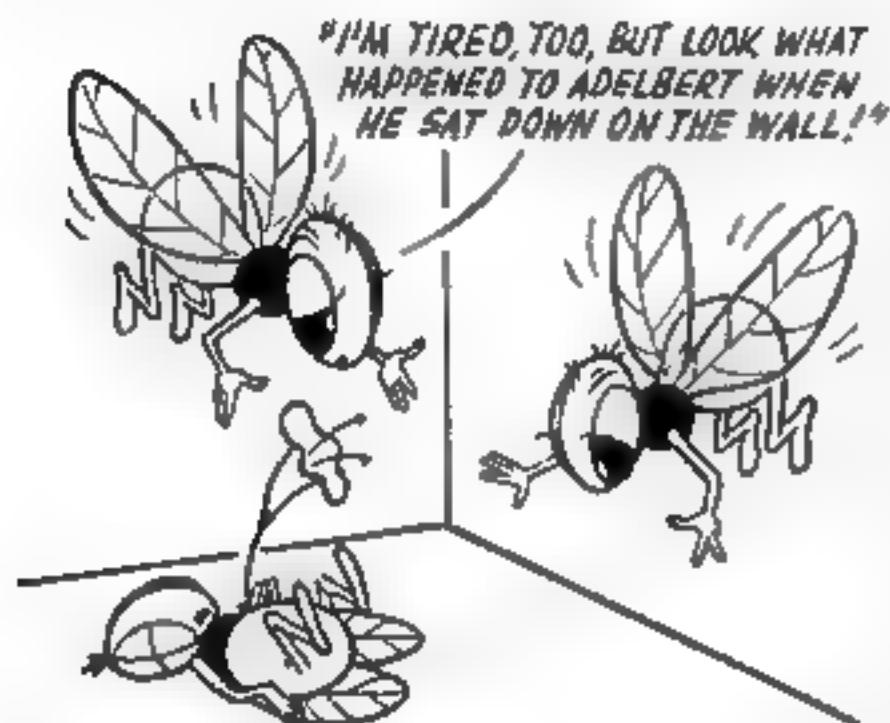
Nearly everybody by now has heard of DDT, for instance—DDT, the sensational new insecticidal agent with which the Army deloused the whole civilian and military population in the Mediterranean area, and with which more recently virtually every

DDT STRIKES WHERE INSECT PESTS GET IN THEIR DIRTY WORK



THE "BUGS" OUT OF LIVING

Miracles as Mosquito Bombs, Wrinkleproof Fabrics, and Stickproof Doors



mosquito and fly on several Pacific islands was exterminated (see page 155). Obviously a chemical that will do such wonders in the prosecution of a war can be expected, when the proper time comes, to do at least equal wonders around the house in a world at peace.

When these good times come there will be a sad day for houseflies. Mrs. Postwar American will be able to make her house a deathtrap for them. Using an ordinary insecticide gun, she will simply spray her walls with a solution of DDT. As the solvent evaporates, a practically invisible residue will remain on the walls—and for months every fly and mosquito that lights on those walls will die. If Mrs. Postwar American does not like to spray the walls, she may direct the gun on the screens and, since insects invariably visit screens at some time or another, sooner or later the final result will be the same.

She will also be able to spray clothes and other fabrics, and make them sure death to moths. But she may not even have to do that. The Geigy Company, which first discovered the insecticidal value of DDT, has specialized for years in dyestuffs, and the very discovery came about through experiments to find a chemical that could be used like a dye to impregnate fabrics and make them mothproof. Thus, many clothes and fabrics may already be mothproofed when they arrive in the home of tomorrow. In that case, they will be able to stand several launderings without losing the effect of the DDT, but not dry cleaning. Of course, the stuff loses its potency eventually anyway—in a matter of months

—and dry cleaners will probably be prepared to reimpregnate the clothes periodically.

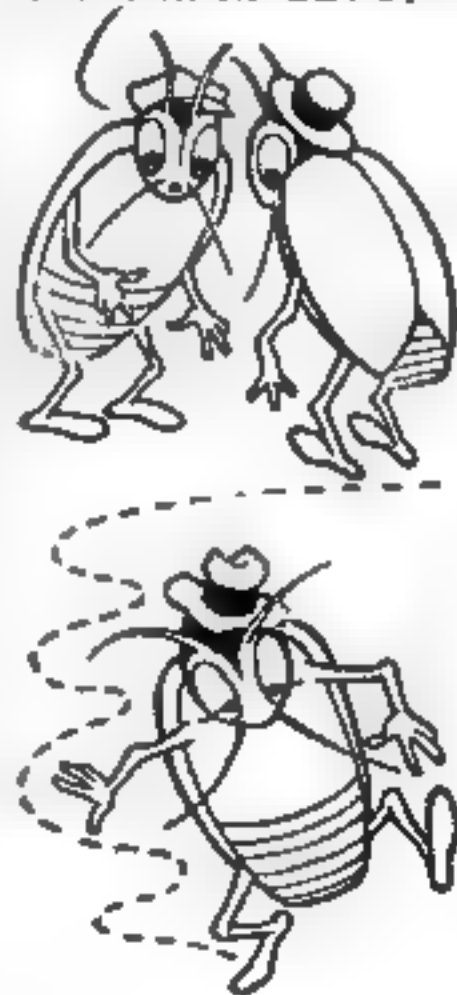
Silver fish, those troublesome insects that attack book bindings and some fabrics, are easy victims of DDT in powder form. Mrs. P.A. will sprinkle the powder in their haunts, and then just wait for them to die. She can kill cockroaches that way, too, if she applies the powder to the hiding places and runways of these kitchen-infesting insects. In fact, the success of DDT in killing cockroaches has been so startling in one large restaurant, where the Geigy Company has conducted its experiments and where every other product, up to now, has only given partial control, that the proprietor calls it the "miracle" powder. During the first few hours the effect is not immediately apparent, but the powder is persistent and is effective for a long period of time.

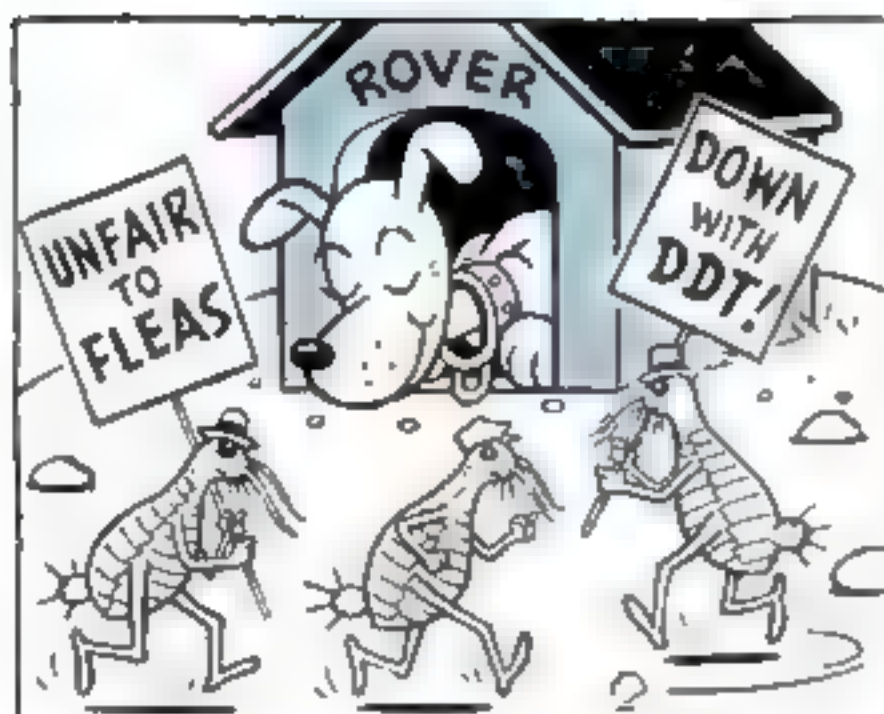
Speaking of the more obnoxious insects, if our family should be so unfortunate as to be troubled by that terror, the bedbug, DDT will again come to the rescue. A composition that has found practical use is a 5-percent solution in kerosene or deodorized kerosene. After having been sprayed on bedsteads, springs, and mattresses, this composition has given a residual effect for over 300 days—nearly a full year—with one application.

Then there is old Rover's problem. Tests have proved that a dusting with DDT will kill all his fleas, and for at least a week will keep on killing any new ones that may land on him. A bath with DDT emulsion will kill not only fleas, but ticks will succumb as well, and with no bad effects on the dog so far as tests have yet shown. What a postwar world for Rover—no bites, no scratching! And if our householders will spray areas infested by ticks or jiggers, they will be able to kill them off at the source.

If they have a barn and keep a horse or a

LET'S GET OUT OF THIS JOINT—THERE'S ANOTHER ONE WITH TH' DDT'S!





cow, they will surely want to spray the inside walls. This will keep the animals happily free from flies and bugs for weeks on end or for months. How much DDT will be used outside the house, however, is still a moot question. The stuff is so powerful that there is admitted danger of killing beneficial insects as well as the harmful ones—perhaps even some other forms of life, such as fish or birds. It is certainly fatal to bees, and any spraying of fruit trees will have to be done when they are not in bloom lest the bees gathering nectar die along with the pests. But DDT is so efficient a killer of such public enemies as the Japanese beetle and the gypsy moth that methods for using it safely for such purposes will almost surely be worked out by the time it is ready for the civilian market.

Admittedly, like other insecticides, DDT is more effective against some insects than against others. Termites succumb to it if it reaches them, or they reach it, but no penetrating solvent has yet been developed to carry it into the wood where they lurk; it can only be sprayed around the exposed places before they get into the wood to do their dirty work. Some kinds of ants—black ants in particular—seem to resist its effects; and tests are still being made to determine its effectiveness in combatting many other insects.

At the close of the fifty-sixth annual meeting of the American Association of Economic Entomologists held recently in New York, a statement on DDT was adopted by 392 delegates representing 1,600 members. It praised DDT in these words: "We

feel that never in the history of entomology has a chemical been discovered that offers such promise to man for relief from his insect problems as DDT." But it warned that there are limitations and qualifications.

"Subject to these [limitations and qualifications]," the statement went on, "this promise covers three chief fields: public health, household comfort, and agriculture."

In the field of public health was included control of disease-carrying insects such as those that transmit malaria, typhus, and yellow fever. The statement pointed out the possibility of complete eradication of malaria in this country. It also listed as a possibility the complete eradication of bed-bugs. Although great promise was held for the effectiveness of DDT in agriculture, the statement warned that this field has so far been the least explored.

"To illustrate," it said, "it is a superior insecticide for control of codling moth on apples, but in some sections at least it will kill certain natural enemies and thus release other insects which may then become major

problems. The research reports emphasize that we have not had time to develop entirely satisfactory mixtures and dosages of DDT insecticides, nor the method and time of application for many possible uses."

How soon Mr. and Mrs. Postwar American will be able to get DDT depends partly on when war needs relax and partly on how long it takes to complete various experiments and investigations, some of which are already being undertaken. DDT—*dichloro - diphenyl - trichloro-ethane*, to give it the full name—is not a complete insecticide but a killing agent that must be combined with other ingredients. Many projects are now under way to determine just what ingredients combine with it most effectively for various uses and in what proportions. All this will have to be worked out before it is put on the general market so that our Postwar American family can buy the

proper compound with directions for use.

Then there is the question of how toxic it is to man and animals. A man or an animal can certainly be poisoned by taking enough of the active ingredient into his system, but the finished insecticidal material contains only a relatively small amount of DDT, and as a consequence this is much more safe to handle than the pure chemical form. In the relatively weak concentrations



in which DDT is effective for household purposes, the latest reports from health authorities have indicated that it presents no serious health hazard.

Dr. Paul A. Neal, chief of the research section of the Division of Industrial Hygiene of the Public Health Service, reports that, in spite of its inherent toxicity, DDT in the desired insecticidal concentrations in air is of such low order that it will not cause injurious effects in humans. Studies of powders used for dusting clothes showed that in concentrations up to 10 percent there were no serious health consequences. Only one out of three dogs breathing air containing relatively high concentrations of pure DDT showed definite signs of poisoning after 18 days. The tests dealt only with inhalation of aerosol, dust, and mist, but Dr. Neal warns that large doses by mouth or skin absorption will cause toxic effects.

Even without the potent DDT, bugs are going to find life a lot more difficult in the home of the Postwar American family. Aerosol bombs may be on the market—somewhat more expensive than ordinary spray guns, to be sure, but also much more effective. The spray that our fly and bug-hating family will get from aerosol bombs will come out in a fine mist, penetrate into all nooks and corners, and kill all the insects in the room whether the thing is aimed at them or not. That is so because the liquefied gas in the bomb breaks up the insecticide into much smaller particles than when it is pumped out of an ordinary spray gun.

The Army has been using a pyrethrum spray in aerosol bombs, but in some recent tests DDT has been added with good results. But even if the aerosol the P.A.'s buy after the war still employs only a pyrethrum spray, it will be a better one than they have been using. For one thing, it will very likely be odorless and nonirritating, so that

they can use as much as may be needed without the danger of unpleasant personal results. Three Department of Agriculture chemists have developed a way to remove all the impurities and produce practically pure pyrethrins—the toxic agent—from pyrethrum flowers.

Meantime, chemists have brought forth something that bids fair to be as rough on



He treated half his shirt with wearproofing chemical.

microbes as DDT is on insects: organic mercurials. These chemicals derived from mercury are 15 times as powerful as carbolic acid for use as a disinfectant, and yet they are odorless, colorless, and nonirritating. The possibility immediately arises that our postwar family will be able to get products of this nature to treat garments, bedding, and upholstery, thereby keeping colds and other diseases from spreading. A few drops in the laundry rinse water would apparently do hygienic wonders to clothes. If the family sends the washing out, the commercial laundry could do the hygienic job as an added service at hardly any extra cost. Several diaper services are already doing just this for the greater protection of babies using their wares.

And these organic mercurials work a double magic. They make clothes last longer. This is so because many "worn-out" clothes are not worn out at all but simply rotted out. Bacteria, attacking perspiration absorbed by the fabric, weaken the material and make it vulnerable. One chemist who has been working on organic mercurials proved this recently by treating one half of a shirt with his mercurial and leaving the other half untreated. The treated half remained intact long after the untreated half was more than ready for the rag bag.

Another chemical advance that promises the P.A. family longer-wearing clothes and household fabrics is in the field of nylon. Du Pont chemists expect not only stockings but all sorts of fabrics to be made of nylon

You'll sing in the rain with wrinkleproof clothing.





Fire-resistant fabrics foil the youthful arsonist.

in the years ahead. These fabrics will be used for clothes, curtains, rugs, upholstery materials, and various other purposes. In the humid South Pacific, where fabrics often rot to pieces in a matter of days, the Army has been using nylon not only for parachutes but for such diverse items as hammocks, screens, and shoelaces because of its low moisture absorption and its resistance to mildew and rot. It also, of course, has no appeal to the appetite of insects. And it will save Mrs. P.A. a lot of ironing because once nylon is set in shape—whether in crinkles, pleats, or a perfectly flat style—it keeps the shape indefinitely.

If our housewife prefers to use ordinary fabrics, she may still save herself a lot of trouble at the ironing board by getting those that have been creaseproofed in the making. Chemists have now fully developed methods of treating yarn with synthetic resins so that when it is manufactured into cloth it will not wrinkle or crease. By treatment with a complex organic salt, the same cloth can also be made water-repellent and even spot-resistant so that any nonfatty smudges or spots will sponge right off.

Mr. P.A. will probably be more interested in the fact that he can reduce the fire hazard in the house by having curtains and other easily inflammable fabrics treated to make them fire-resistant. Curiously enough, the chemical that will be used for the purpose—and is already being used in a number of war plants—is the same one that will kill his weeds and poison ivy, ammonium sulfamate. Mr. P.A. will do the weed killing himself, simply spraying the obnoxious growth and letting the chemical do the work; but probably a laundry or a dry cleaner will apply the chemical for fire-resistant purposes. After the fabric has been treated—whether it is a curtain, a rug, or a garment—it will still burn if put right

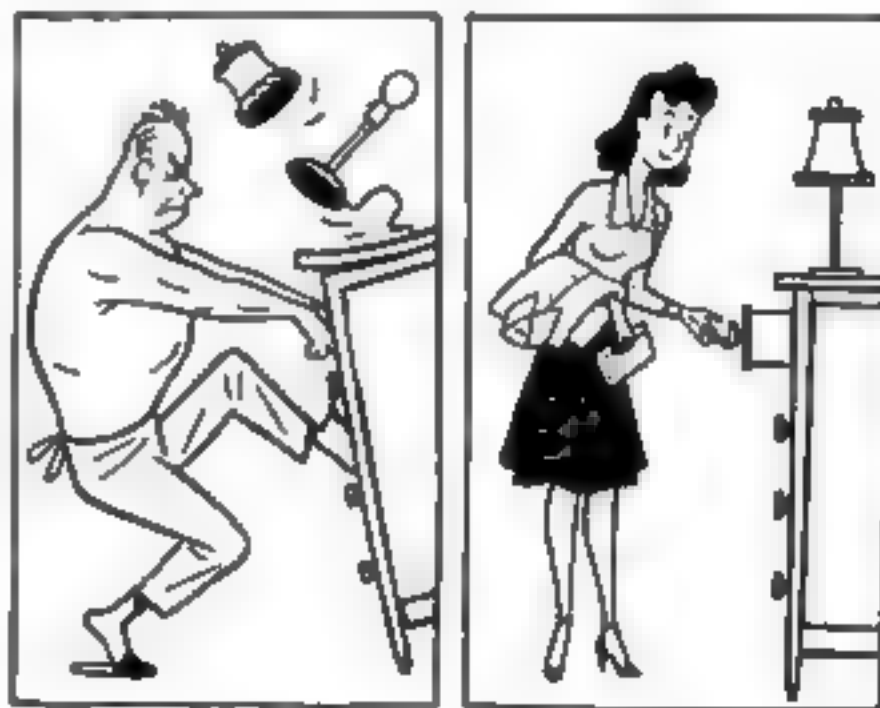
in a flame but, no matter how flimsy the material, it will go out as soon as the direct contact with the flame is lost.

While he is about it, Mr. P.A. may well make use of another chemical discovery—particularly if he is building a new house—and install fire-resistant wood over the furnace and in other places where a fire might get started in woodwork. In this instance, what he will use will be wood impregnated with chromated zinc chloride. Chemists developed this treatment some years ago to make wood termiteproof and rot-resistant and have now found that by doubling the dose they can also make the wood almost as fire-resistant as asbestos.

In that new house, too, Mr. P.A. will certainly want to use some of the chemically transmuted wood that will be on the market for doors and windows. This wood, impregnated with methylolurea, loses much of its natural tendency to swell or shrink or warp with changes in humidity, and it is also made harder, stiffer, and more durable than it is in its normal state. It will give the P.A. family doors and windows that refuse to stick.

Their postwar-made furniture, if more of the chemists' marvelous new tricks are used in its manufacture, will have other advantages to their liking. Newly developed adhesives will foil joints in their old annoying habit of coming apart. Tough lacquers will be anchored on the surface in such a way that it will take brute force to scratch the finish. Some treated wood will be dyed all the way through so that, even if it is scratched or gouged, it can be sanded or planed down and made to look like new again.

Yes, a lot of things are going to be new and different around the house of Mr. and Mrs. Postwar American and family—thanks to the chemists.



Swell new chemicals will keep wood from swelling.



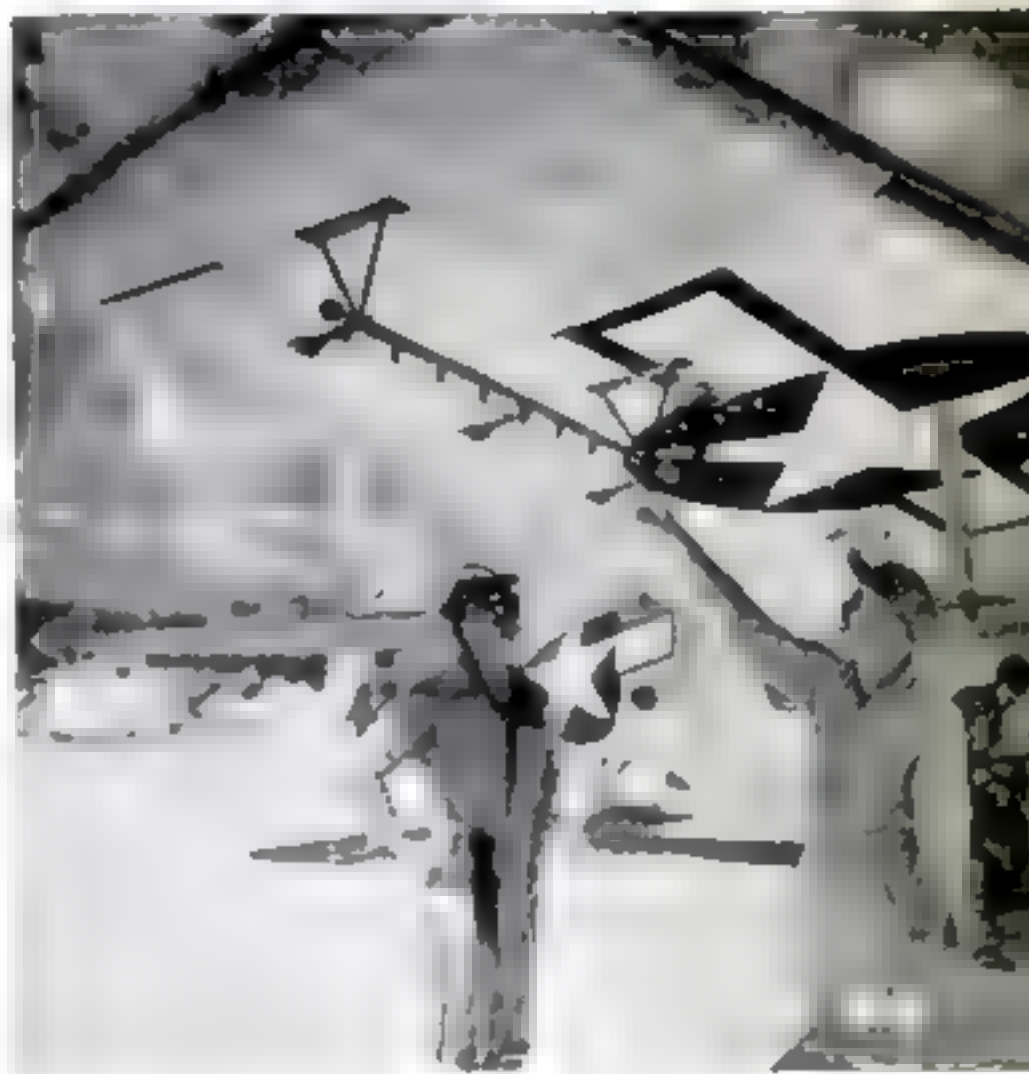
While Marines eliminate the Japs, a DDT-carrying bomber eliminates mosquitoes with equal thoroughness.

“Flying Flit-Gun” Strafes Insects with DDT

DISEASE-CARRYING mosquitoes and flies have at last met their master in the “Flying Flit Gun.” Avenger torpedo bombers, equipped with nozzles for spreading a spray of DDT and Diesel oil, have winged low over Pacific islands, blotting out almost entire insect populations. As a result, in one island recently wrested by the Marines from the Japs, not a single case of insect-borne disease has been reported. Even before the island was won, mosquitoes had been entirely eliminated, and flies and other insects brought under control.

Beginning less than a day after the captured airstrip was put into operation, Marine pilots began systematically spraying every square yard of the island, thus giving the Nips a few insect-free days before they were mopped up. To do the work, the Marines chose the Avenger, largest single-engine plane available to them. A short length of perforated pipe was mounted under each wing and connected with a 270-gal. belly tank. Flying low at 125 m.p.h., the bomber was able to spray a 250' swath of insecticide.

For the bigger islands to come, the Marines have an answer: a great Commando transport, equipped with huge interior tanks and enlarged wing sprays, able to spew out DDT solution eight times as fast as the “Flying Flit Gun” can.—S/SGT. DAVID STICK.



Lieut. Bollew, above, pilot of the “Flying Flit Gun,” examines the spraying nozzles pointed out by Lieut. Aikin, medical officer who supervised the mixing of DDT and Diesel oil. Below, Marine crewman pump the magic insecticide into a belly tank of the plane.





INSIGNS ON
UNDERSIDE
OF WING

CURTISS SB2C
HELLDIVER

PLANS ARE HALF SIZE

DIVE BOMBER IN MINIATURE

True-to-Life Scale Model of the Navy's Distinguished Helldiver Makes a Worthy Addition to Your Mantlepiece Plane Collection

WHEN we attacked the Japs at Rabaul, we unleashed against them a hitherto untried weapon—the Helldiver. Since then this plane, a dive bomber made by Curtiss, has pursued the enemy throughout the Southwest and Central Pacific, bombing and strafing them in an awesome manner. Carrier based and amazingly versatile, it is called the world's biggest, fastest, and deadliest dive bomber.

A two-place monoplane of semimonocoque construction, the Helldiver has an over-all length of 37' and a full-cantilever wing that spans almost 50'. Although it weighs nearly seven tons, the plane can take off from and land on the smallest of baby flattops, thanks to the mechanically operated quick-opening wing flaps.

It is powered with a Wright Cyclone air-cooled radial engine and equipped with a three-blade Curtiss electric constant-speed, full-feathering propeller, which is made of hollow steel and is 12' in diameter. The retractable landing gear, the folding wings that facilitate storage aboard ship, and the bomb-bay doors in the belly are all hydraulically operated.

As you did when building the other models in this series, first lay out a full-size draw-



Latest of our dive bombers, the Helldiver carries a larger bomb load than any other similar aircraft—and carries it faster and farther.

ing of the plane, using the accompanying half-size illustration as a guide. Carve the fuselage to shape; then slot it to take the wing. This is made in one piece. It can be cut at the points where it folds, if desired, and small flush hinges inserted. Make the rudder and elevators from 3/16" stock. Glue them and the wing to the fuselage and fill in the crevices with plastic composition wood, building it up to form fairing fillets. Use match sticks for the wing-mounted machine guns and Pitot tube and for the fuselage-mounted aerial. The propeller is a celluloid disk with a hub cut from doweeling. Paint the underbody light blue and the topsides gray, as shown in the photos.

Incorporating new features derived from actual dive-bombing experience, the latest model of the Helldiver, shown below, features a four-blade propeller and a more powerful engine.

Called "Fist of the Fleet," the plane folds its wings to facilitate stowage when based aboard an aircraft carrier.

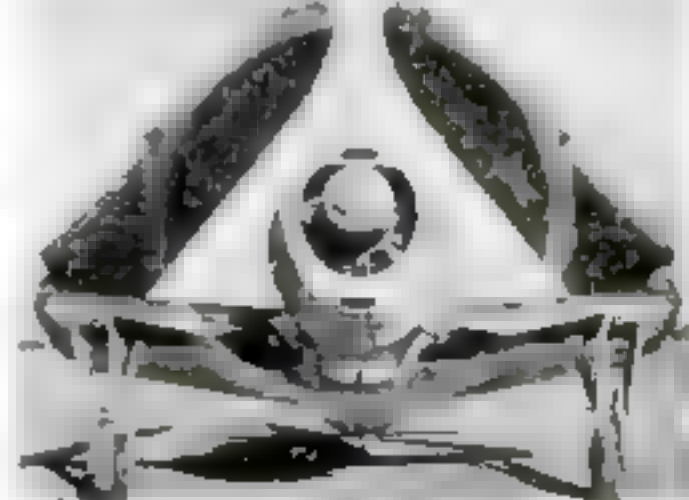
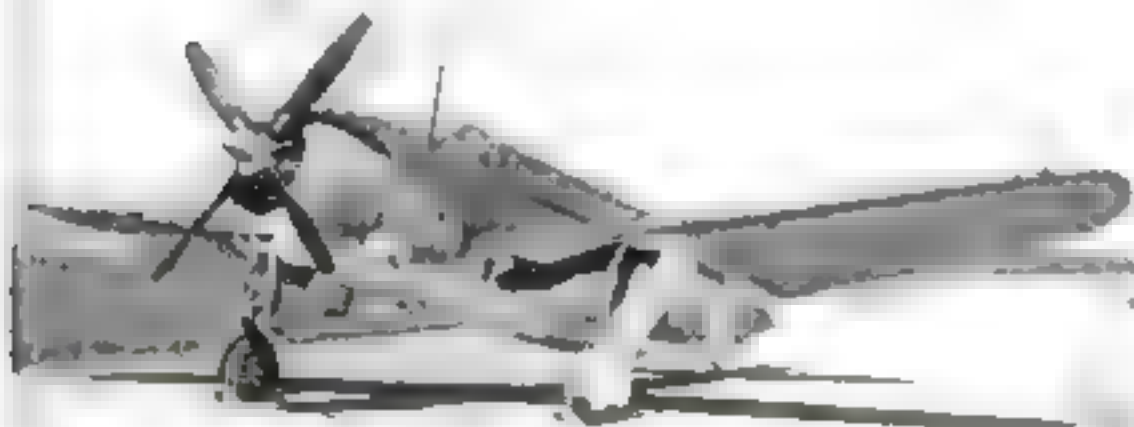


TABLE TRICKS

HIT THE TABLE 3 TIMES with a NAPKIN and a **KNOT** APPEARS!



① TIE KNOT and CONCEAL IN HAND. ② BEFORE HITTING TABLE EACH TIME, RUN NAPKIN QUICKLY through OTHER HAND. THE 3RD TIME, **SWITCH ENDS!**



VIBRATING MIXER STICK

① MOISTEN GLASS STIR-STICK and CLASP IT IN MIDDLE—

② PUSH STICK THROUGH FIST WITH *the* THUMB WHILE HOLDING STICK AGAINST TABLE OR GLASS.

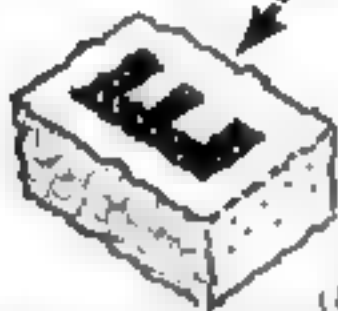
The CORRECT TOUCH SOUNDS like **A RIVETING GUN.**



RAT-A-TAT!

THINK OF A NUMBER. DOUBLE IT. ADD 5. MULTIPLY by 50. ADD *the* AMOUNT OF CHANGE IN YOUR POCKET (UNDER A DOLLAR). **SUBTRACT** *the* NUMBER OF DAYS IN A YEAR. ADD 115. THE RESULTING DIGITS AS READ ARE THE ORIGINAL NUMBER FOLLOWED by *the* CHANGE IN YOUR POCKET!

① DRAW INITIAL (HEAVILY) ON LUMP SUGAR



② DROP IT INTO A GLASS OF WATER

INITIAL BEGINS TO DISAPPEAR (MELT)



③ PLACE PERSON'S HAND OVER GLASS



④ INITIAL JUMPS TO PALM!

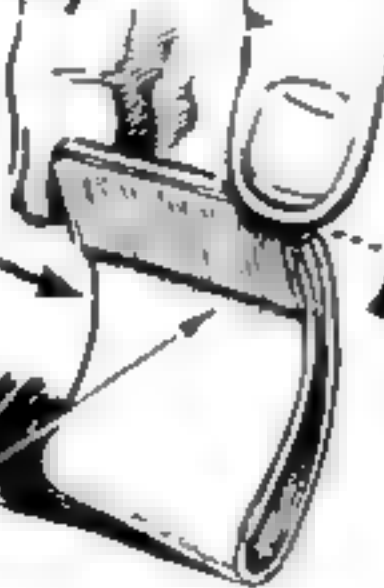


EXPLANATION. TOUCH INITIAL with *YOUR* THUMB, PRESS PERSON'S PALM with THUMB★ IMPRINT.

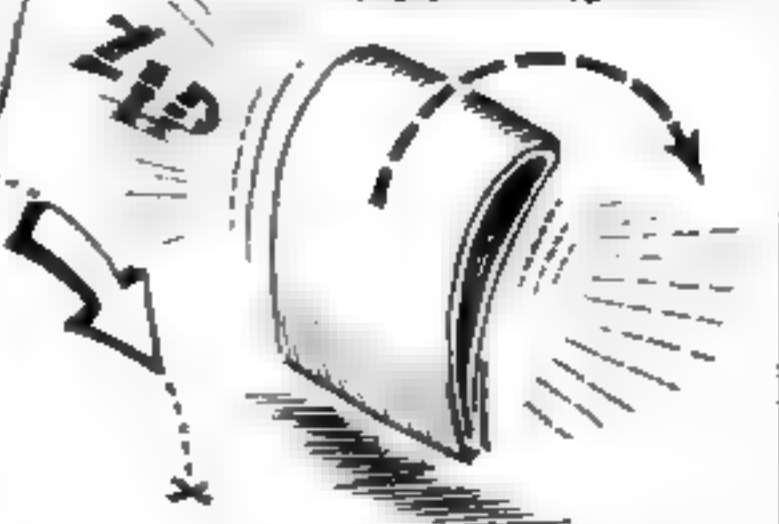
① TEAR MATCHES *out of* PACK

② BEND *the* FOLDER IN CURVE EXACTLY AS SHOWN (CURVE WELL)

③ HOLD FOLDER AS SHOWN and LET IT FALL ON ITS CURVED BACK. (HEAVY END UP)



④ ...IT DOES A MAGIC SOMERSAULT



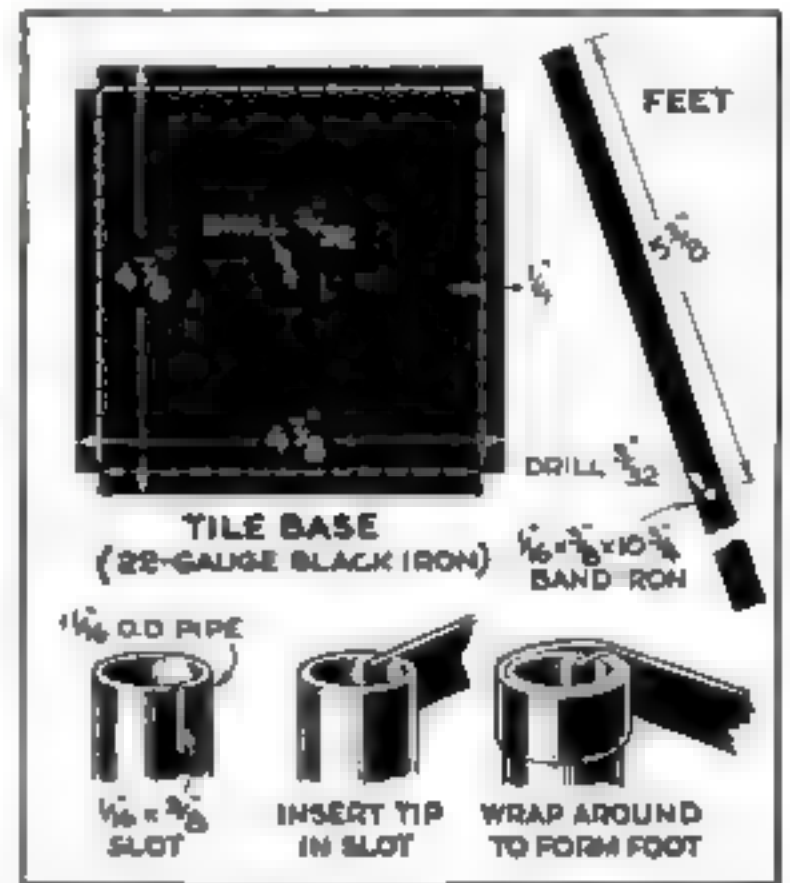


Teapot Tile

GIVEN a colored tile, a few pieces of metal, and a little time, you can turn out a hot-dish stand that will not only be useful but will add materially to the decorative effect of your table.

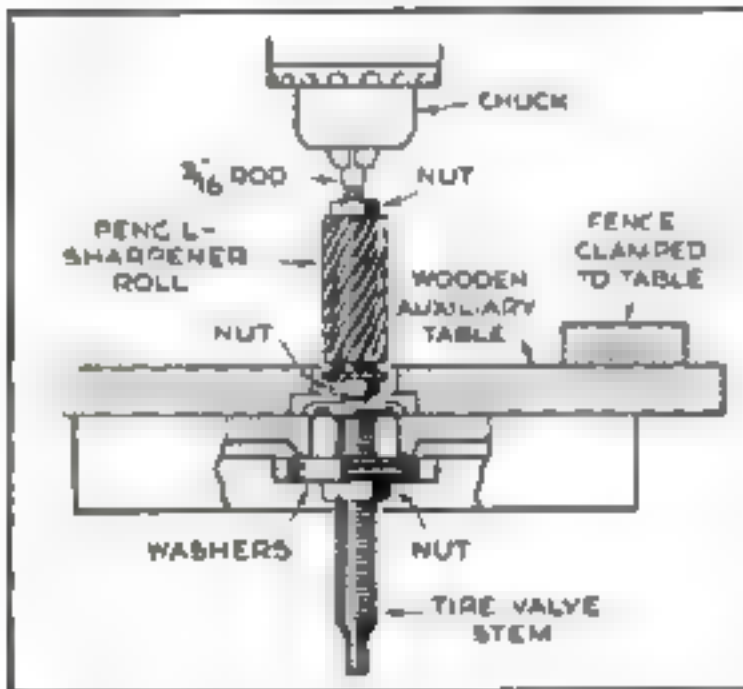
On a sheet of lightweight black iron or heavy tin plate, mark off a square extending $\frac{1}{8}$ " beyond each edge of the tile. Scribe another square inside it the size of the tile. Using tin snips, cut out the larger square and notch the corners. Clamp the metal and a wood block the size of the tile in a vise and bend over the flanges with a mallet.

Feet, scrolled from two pieces of band iron, cross diagonally under the base and are fastened to it with a single rivet.—G. A. WAGNER.



Use of a slotted pipe as a bending jig is a sure way of forming scrolled feet that match. Bits of cardboard glued under the corners of the tile keep it from rocking.

Homemade Wood Edge-Planer Uses Cutter from Pencil Sharpener



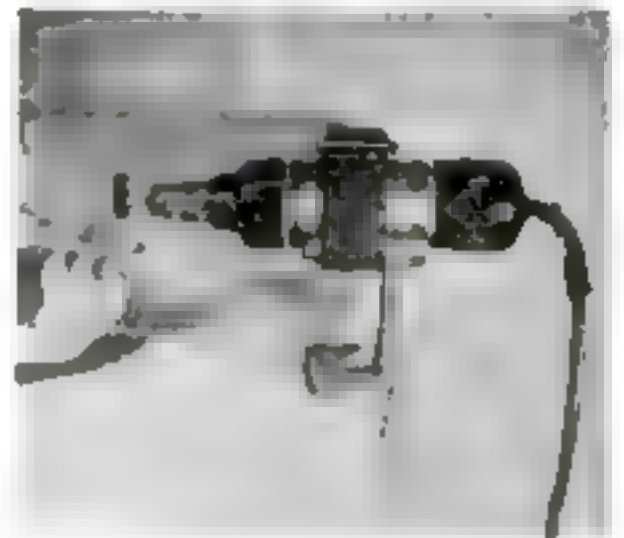
THIS homemade miller utilizes a drill press and part of a pencil sharpener to solve the problem of cutting square, smooth edges on flat wood pieces. Two nuts hold a cutter roll from an office-type pencil sharpener on a $\frac{3}{16}$ " rod which has been threaded $2\frac{1}{4}$ " at one end. The rod itself is $3\frac{1}{2}$ " or 4" long. Its threaded extension fits into and revolves in a tire-valve stem mounted in the center hole of the press table, as shown in the drawing. The unthreaded end is held in the drill chuck.

An auxiliary wood table, with a $\frac{3}{8}$ " hole in the center, should be clamped on the metal table to raise the work surface up to the roll. With an adjustable fence, it is possible to maintain an even distance when feeding the work against the miller, which should be done from left to right. Make certain the whole assembly is centered before using it.—L. O. SURLES.

Old Meat Grinder Clamps Portable Motor

BOTH hands can be kept free for handling the work when a portable motor grinder is held to the bench by a clamp. Only a moment is required to shift back to hand use when that becomes necessary.

The clamp at the right was made by sawing off the top section of an old meat grinder to leave a curved base to fit the body of the motor snugly. A $1\frac{1}{4}$ " or $1\frac{1}{2}$ " leather or fabric belt, cut short and buckled around both the base and motor, holds the tool securely. The grinder base can be clamped to the edge of the work table.—H. R. WALLIN.

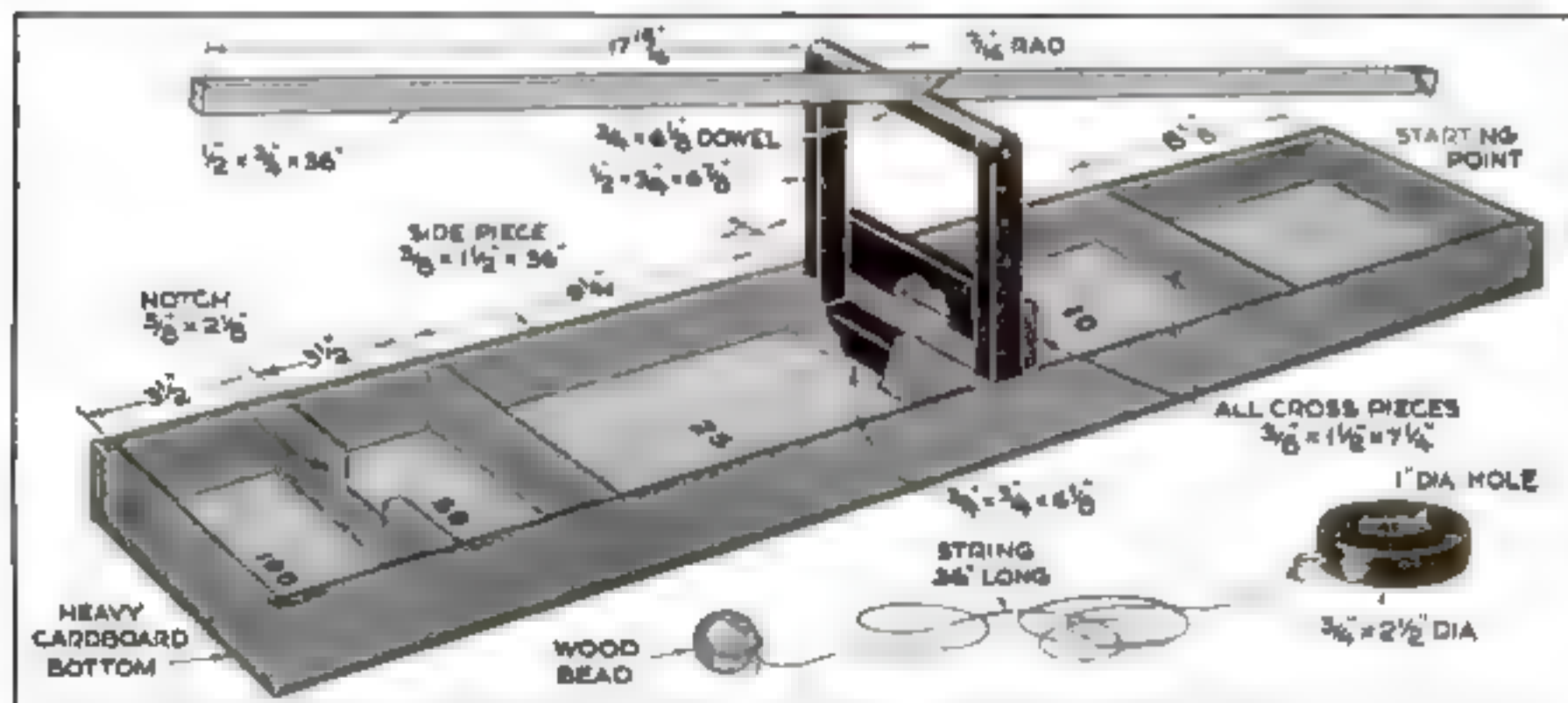
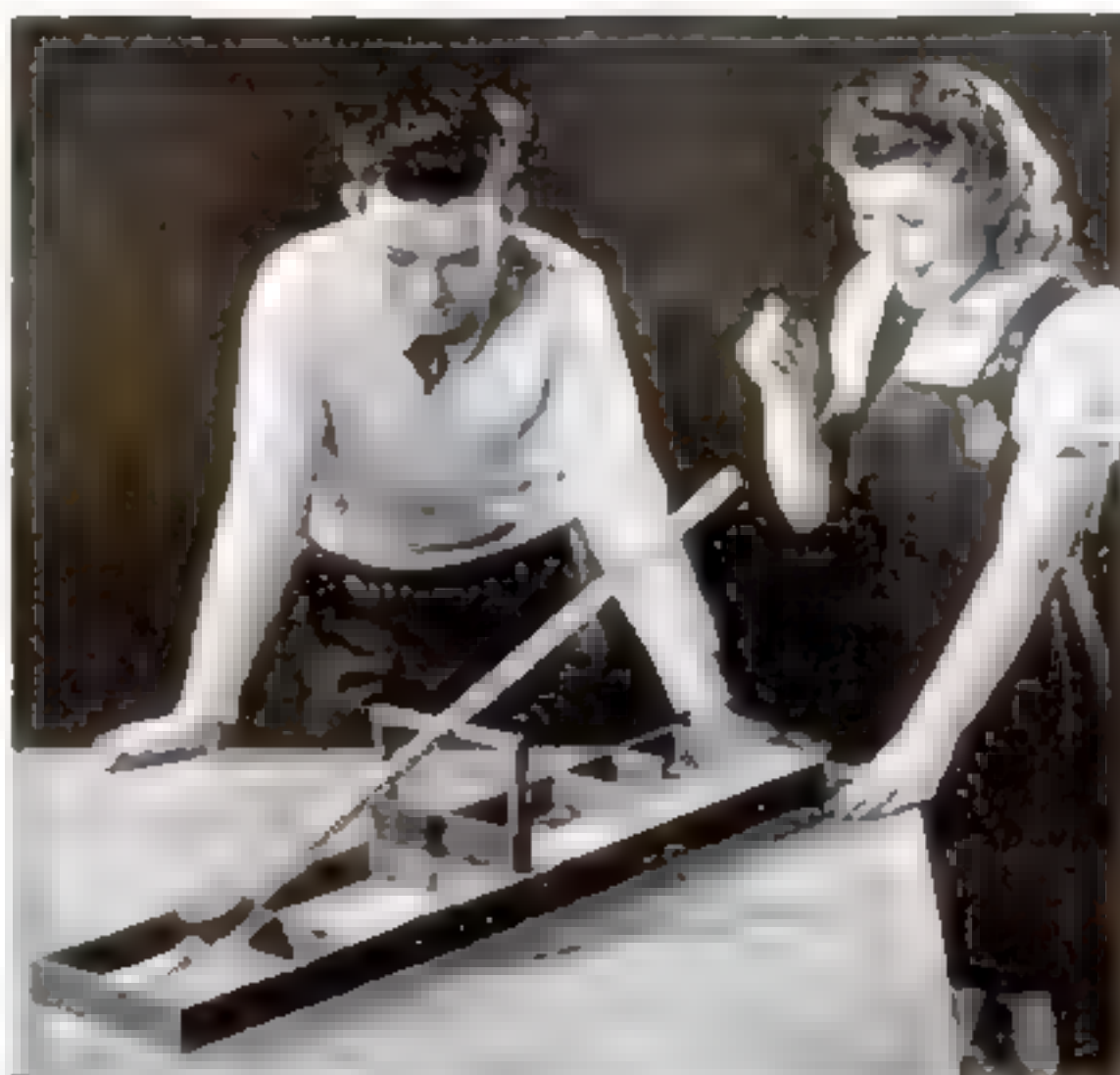


TENSE MOMENTS ABOUND IN THIS SEESAW MARBLE GAME

By Myron Fleishman

AS EASY as falling off a log, thinks the overconfident beginner—until he discovers that the whole trick of this exciting game is to keep the marble from toppling off its narrow track before it reaches a high-scoring position. Too easy? Well, try it yourself. You need only wood, cardboard, and a few hand tools to construct the game board.

Out of $\frac{3}{8}$ " by $1\frac{1}{2}$ " members, construct a frame with outside dimensions of 8" by 36" and divide it into scoring areas, as shown in the diagram. Two crosspieces between the 10 and 25-point scoring areas hold the fulcrum of the seesaw in place during play, but permit it to be removed for compact storage. When making the sliding ring, be sure that the hole is



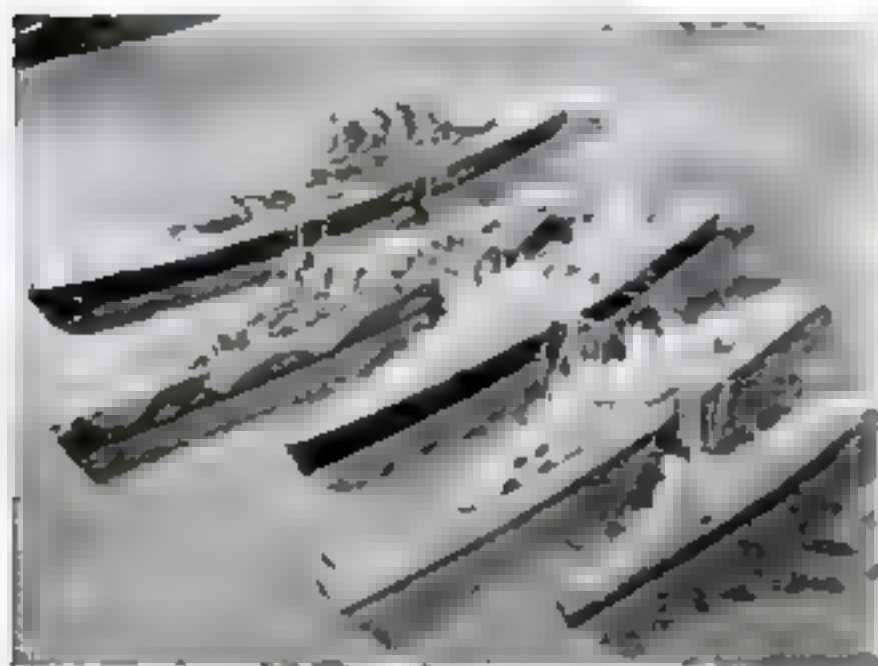
smooth and even and slightly larger than the marble to be used. A heavy cardboard bottom on the board should absorb just enough of the bounce after you catch on, but in your early trials you may have to chase the marble all over the playroom floor. If you want to avoid this, use an inner lining of softer material.

To play, place the game on a level surface, stand behind the high-score end of the board, and drop the seesaw into the "no-score" position. Put the marble in the ring

and balance the ring on the seesaw at the starting point. Then, holding the end of the string, pull the ring along the seesaw bar, over the crest, and down the other side. When the ring goes overboard, the marble falls into one of the scoring sections. Each player has five tries and adds his score for each. The highest score wins. When you get to be an expert, you may want to make the game harder. This can be done by tapering the sides of the seesaw inward toward the high end.



PARLOR FLEET for an ARMCHAIR ADMIRAL



Five gun-bristling warships of the United States Navy are represented in this flotilla. Front to rear: the destroyer Buck, cruisers Atlanta, San Francisco, and Wichita, and 35,000-ton battleship Washington. All are built on proportionate scale.

A miniature Yorktown, the heroic flattop which a Jap submarine sank after she had been damaged in the Battle of Midway, floats at right—alone and under the escort of three guardian warships.

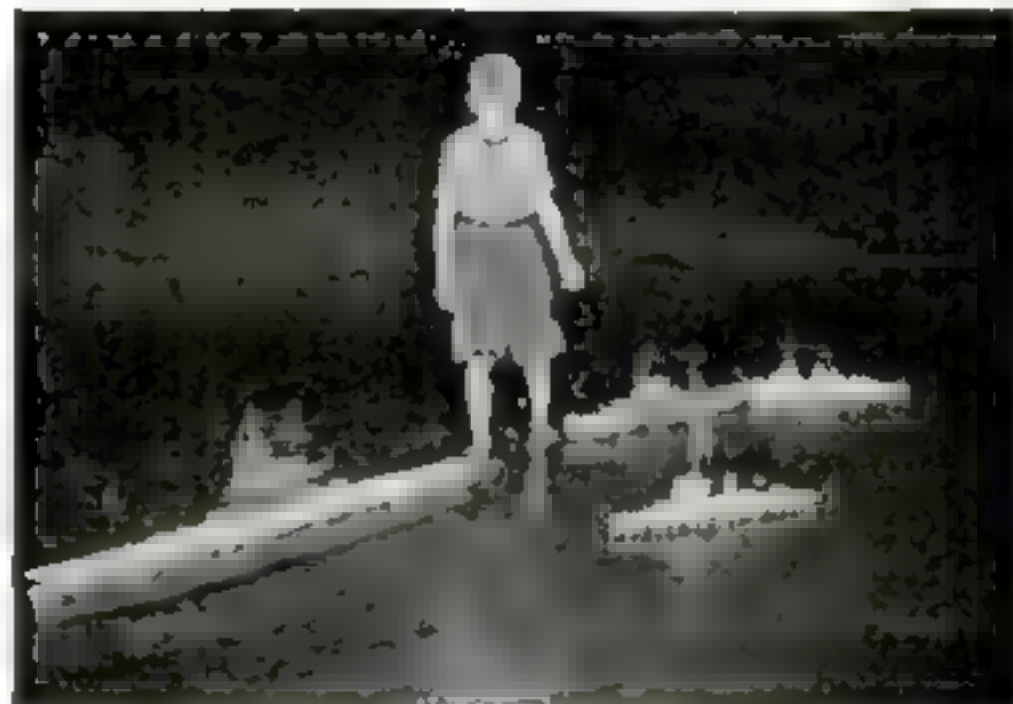
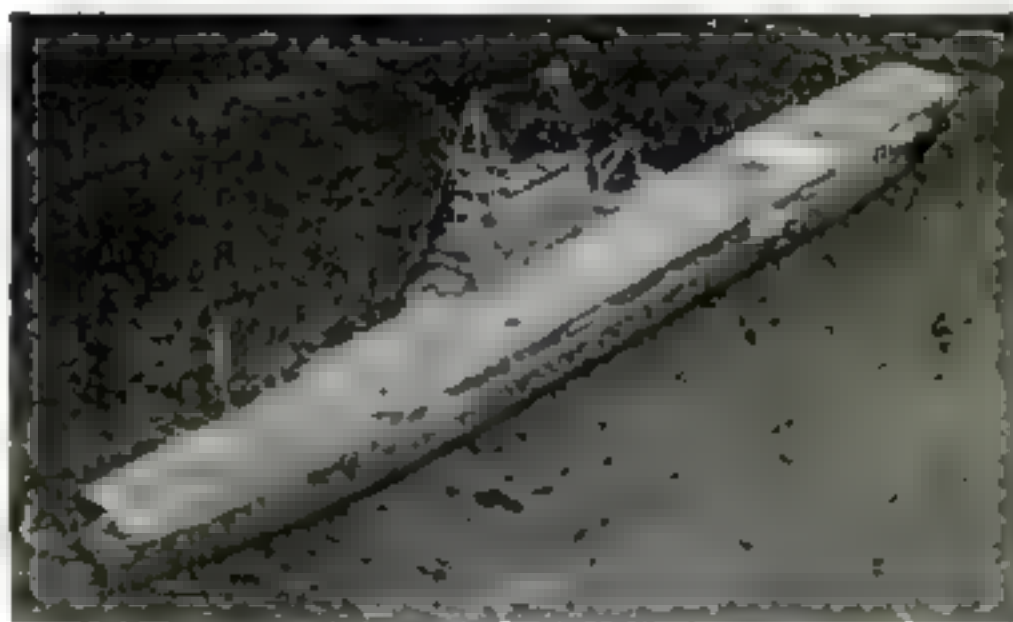
Below, the heavy cruiser Wichita, seaworthy like all Gordon Herr models, presents a trim picture.



CANDY mints and soda straws seem unlikely raw materials for ship models, but Gordon R. Herr of Philadelphia used these and other odds and ends to build 36 miniature vessels.

Beginning in 1931, he experimented for four years before completing the first model. Now, his parlor battle fleet includes an aircraft carrier, battleships, cruisers, destroyers, a destroyer escort, submarines, minesweepers, tugs, a Coast Guard cutter, and an oiler—all exact down to such details as portholes fitted with glass, hull compartments, hollow turrets, movable guns, signal flags, and war paint. All are scaled at 13' to 1" but are not just the usual scale models. Each floats on an even keel at the correct water line.

Using discarded dental instruments, razor blades, scissors, and glue, Modelmaker Herr turned out all the parts himself. He cut aluminum tubing, dowels, throat swabs, and soda straws to size, installing them as guns. Rafts are molded from solder. The mints, licked to shape, became hawse-hole blisters.



Measuring and Scribing Tools for

By EDWIN M. LOVE

WHEN you are fitting a corner cupboard or building a bookcase in a recess, you are the lucky exception if you find the plastered walls true and square. What can you do to assure tight joints that look good and will admit no dust?

Both amateur and professional woodworkers using either hand tools or machines have measurement and layout problems such as this for which no common tools are provided, and shortages of ordinary equipment caused by the war only aggravate this condition. There are a number of homemade measuring and scribing tools, however, that will bridge the gap. Many will prove valuable additions to your tool kit regardless of what you can find in the market. Such tools are a 45-deg. handle for a compass-type scribe, a hinged arc scribe, a set of trammel points, a jointer fence for use with a plane, adjustable inside-measuring rods, and a clamp for nailing miter joints.

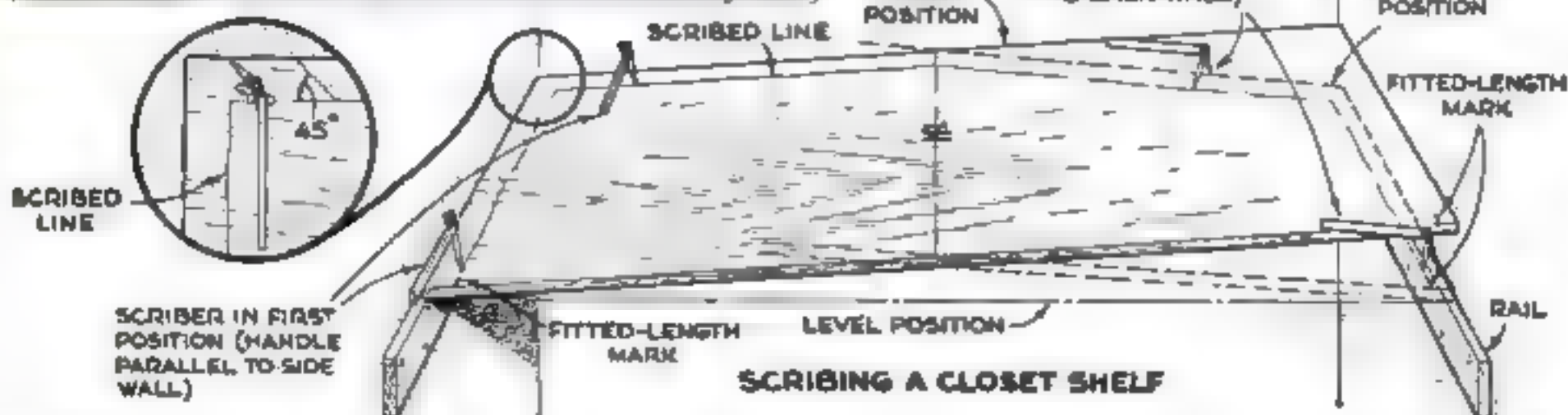
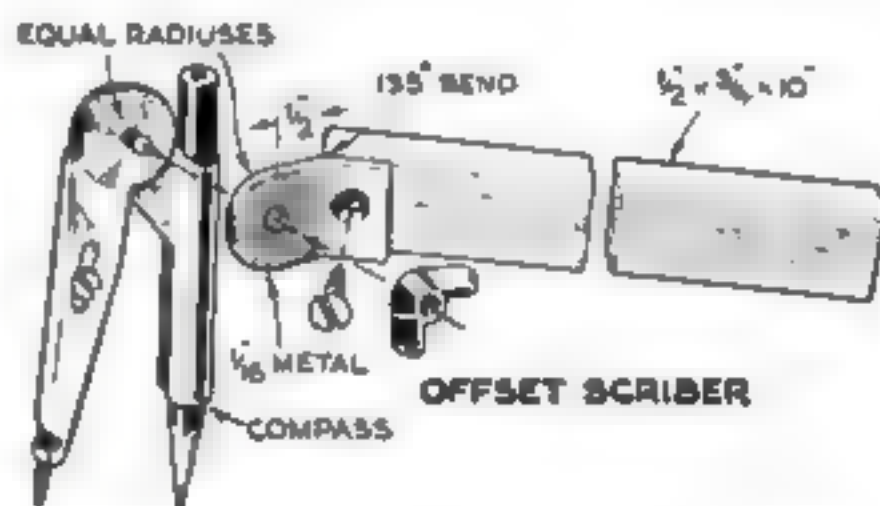
How is an offset scribe handle used? This is the implement that will enable you to fit boards exactly for a corner cupboard or a built-in bookcase. The ordinary scribe used in fitting a board against a plastered wall or other irregular surface is an adaptation of a pencil compass, and it serves very well as long as you have to fit the board to only one surface. You merely butt the board against the wall and, holding the

scriber at right angles to the wall with the point against it, draw the tool along the edge so the pencil traces the irregularities to form a sawing guide.

But when the piece must fit into a corner you begin to run into difficulties. If you should scribe and saw one edge and then attempt to scribe and saw an adjoining one, you would find that the first edge would no longer fit, for its irregularities would be moved to a new position corresponding to the amount sawed from the second edge.

This difficulty is eliminated if a 45-deg. handle is made and bolted to the scribe as shown in the drawing below. By tracing such a scribe along the left wall with the handle parallel to that wall, the scribed line is offset from the back wall just enough to allow for the waste at the back of the board. Then when the scribe is traced along the back wall with the handle still parallel to the left wall, the line is similarly offset with respect to the side wall. Thus, when the board is cut to the lines and thrust into the corner, the movement is along the scribed angle of 45 deg., and both edges fit.

Often a shelf or the top of a cabinet must be fitted at the back and both ends. Such are the requirements for bookcases built into plastered recesses and for cabinets fitted between a wall and the side of a fireplace. Closet shelves are seldom fitted accurately because they don't show, but they



the Woodworker

would be better if they were, for then dust would not collect in the joints.

One of the drawings illustrates the method of fitting the back and both ends. Cut the board about $\frac{1}{2}$ " longer than the finished length will be and mark the fitted length at the front edge. Rest one end of the board on its rail, set the scribe pencil to the length mark, and scribe that end and the adjoining half of the back. Then rest the second end on its rail and scribe that end and the other half of the back. Note in the drawing that the scribe handle is held parallel to the left wall when the left half of the board is scribed and parallel to the back wall for the right half. When the final sawing is done to the scribed lines, the board should fit snugly.

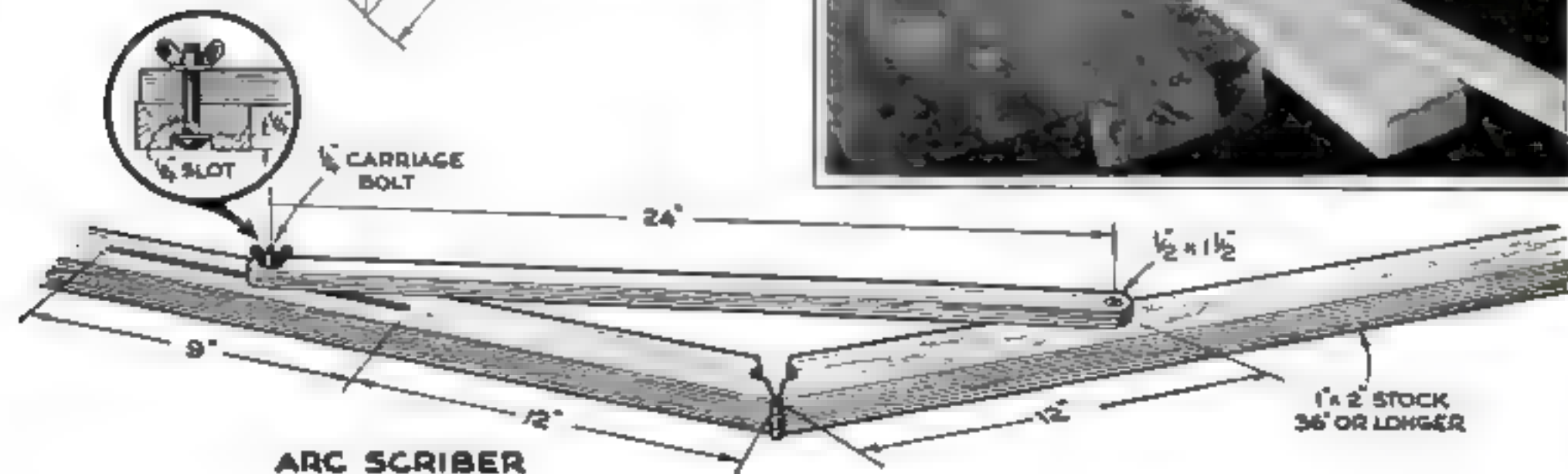
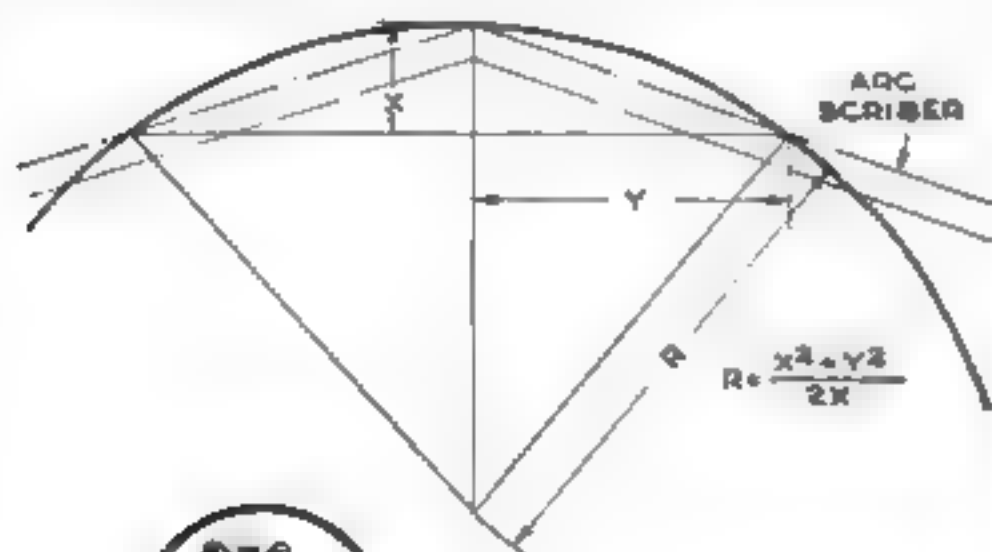
What is an arc scribe? This is a device for drawing arcs of large circles that otherwise would require the use of a long beam and the careful placing of a pivot some distance from the work. The legs of the scribe, as shown in the drawing below, are straightedges 36" or more long. A wood screw holds the clamp bar at one end, while the adjustable end is held in a recessed slot with a bolt and wing nut. Be sure the hinge is attached with the center of the pin aligned with the edge of the legs.

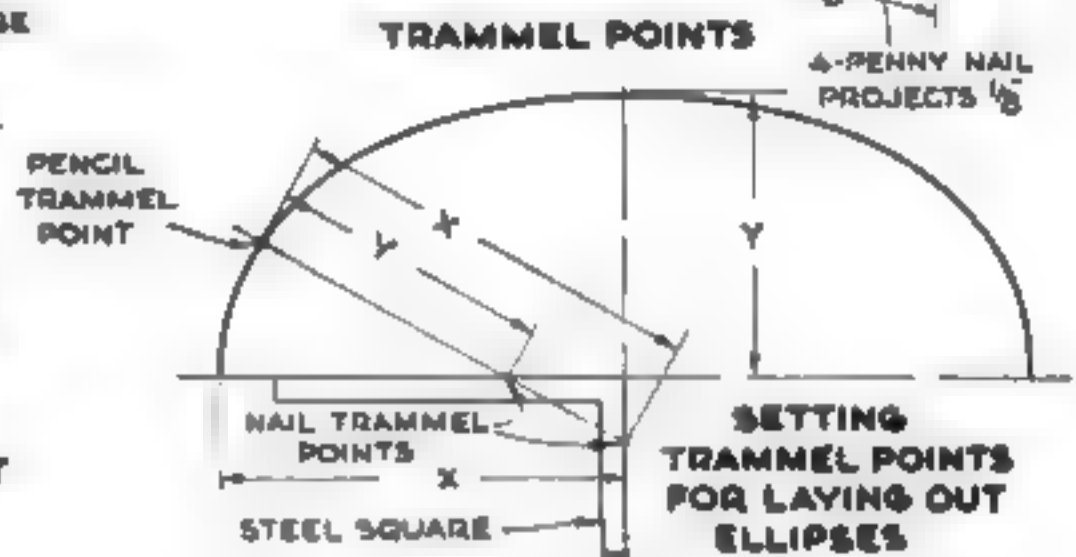
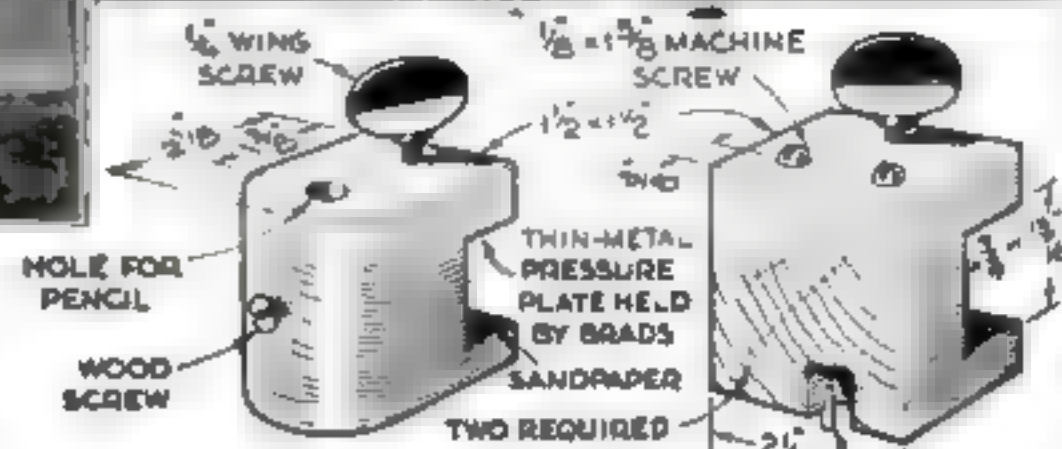
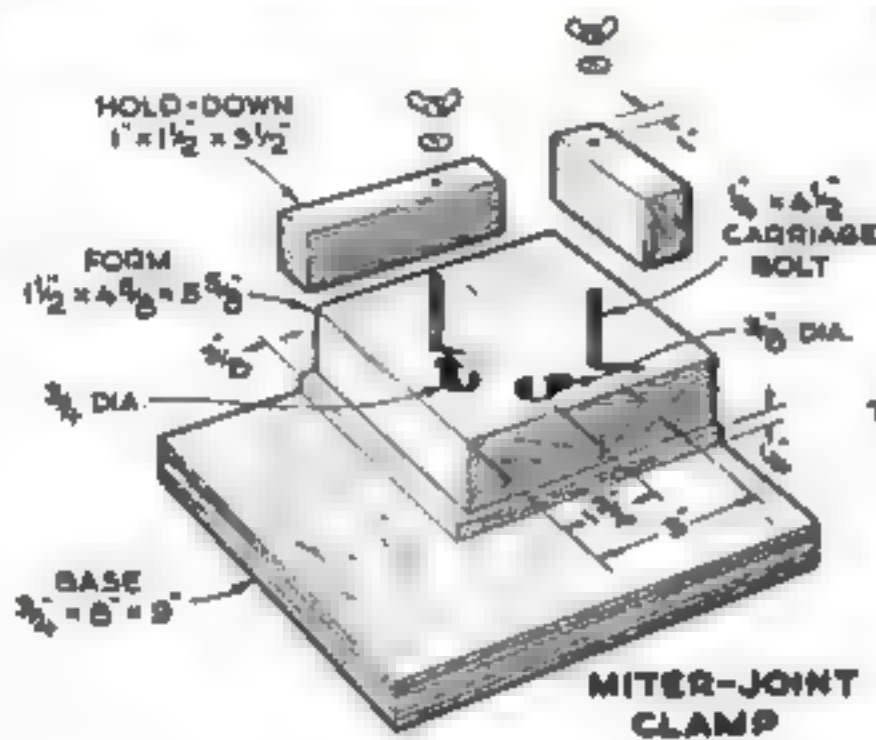
Given the chord of the arc (2Y in the



Use of a jointer plane will assure square planed edges.

drawing) and its "spring" or rise at the center (X), drive a brad in waste wood at each end of the chord and adjust the point of the angle to the top of the spring. Then, sliding the legs against the brads, draw the arc with a pencil placed in a notch filed so as to let the pencil point come under the





hinge-pin center. Most plans indicate the radius and center point, but the radius can be calculated by means of the formula in the drawing. Having the radius and chord, you can scale the rise from the plan.

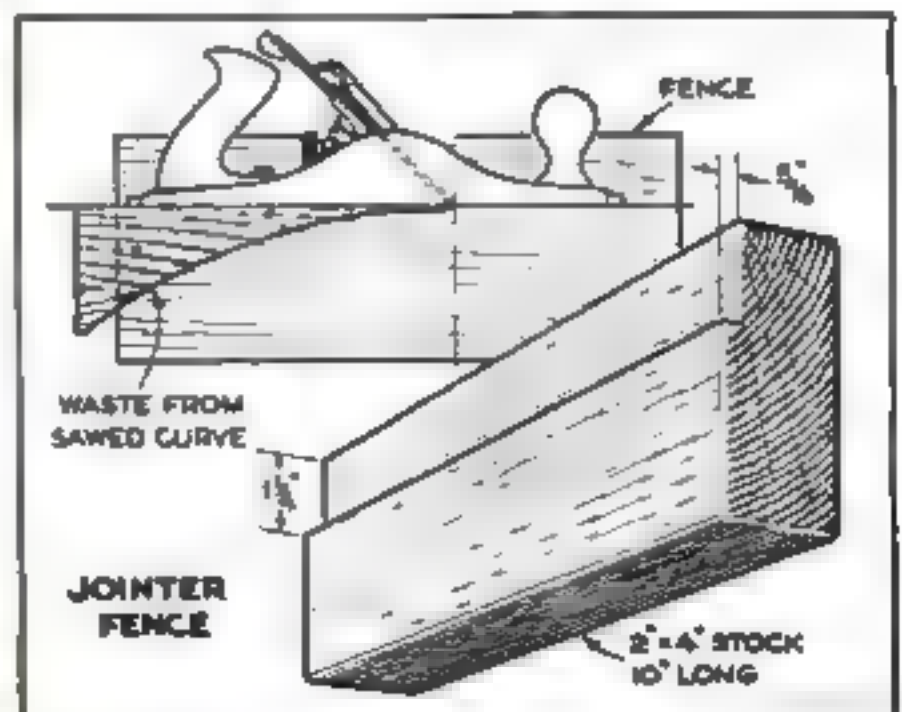
Are trammel points useful? A set of three is very handy for drawing circles and ellipses. The points shown above take little room in the tool kit and can be attached to any straight scrap 1" stock (13/16" thick when dressed). Sandpaper is glued to the lower jaws and pressure plates of thin metal are attached under the upper jaws. Bore 3/16" holes in the upper jaws for 1/4" wing screws which will cut their own threads.

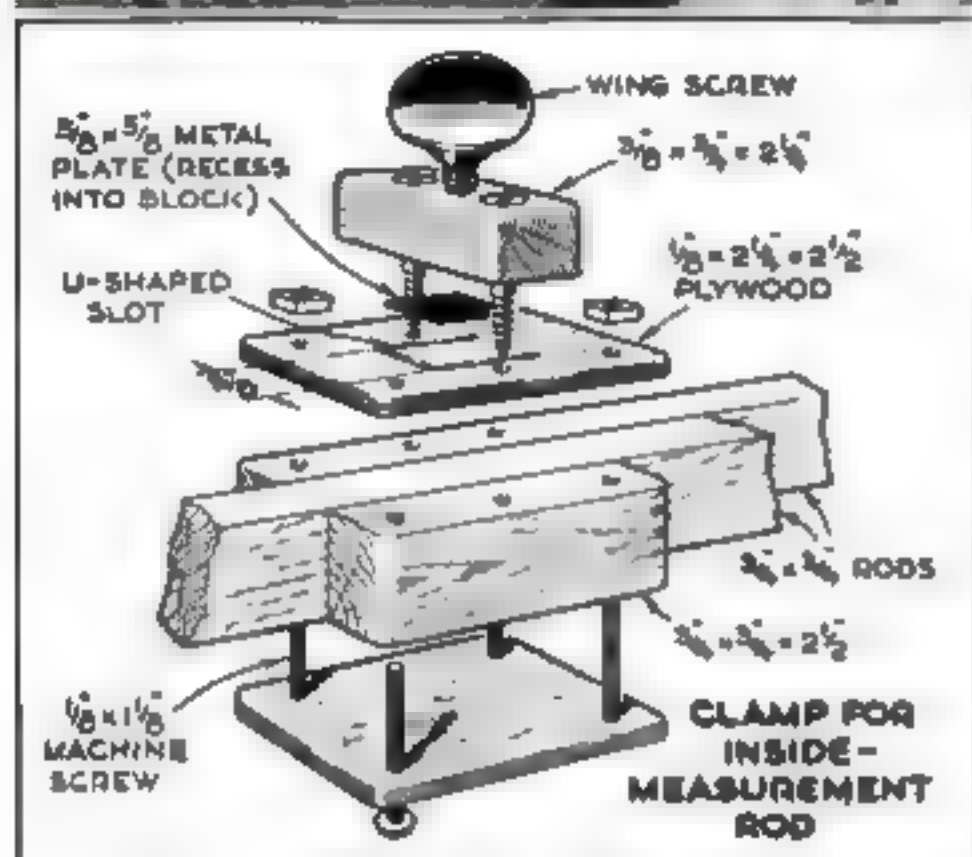
The points are used with a steel square

for drawing ellipses. Set up the points as indicated in the diagram and align the square with the diameters. As you slide the points against the square, the pencil will trace a quarter of an ellipse, which may be drawn on paper or thin wood for a pattern.

How is a jointer fence used? This is a handy gadget for the amateur who finds it hard to square the edge of a board. It is made from 2" by 4" stock, and the rabbet is clamped against the cheek of the plane. Press the fence against the side of the board, and if the edge does not come square, shift the lateral-adjustment lever of the plane to make the iron project evenly.

A triangular strip nailed inside the fence





helps in planing beveled edges, while a length of waste sawed from an arc can be nailed on the inner face just behind the plane iron for use in planing a curve.

What are inside-measuring rods? These are adjustable rods held by a clamp and are invaluable for taking between-wall measurements where it is inconvenient to use ordinary tapes or rules. The clamp is attached permanently to one rod and is equipped with a wing screw that forces down a pressure tongue and holds the sliding rod tight after the adjustment.

In use, the rods are extended between the sides of the space to be measured and are locked in place; then the length can be measured or transferred directly to the work. Two sets of three rods each will be useful. One set might have two 16" rods and one 30" for a 16" to 44" capacity, and the other two 44" rods and one 82" to take measurements from 44" to 126".

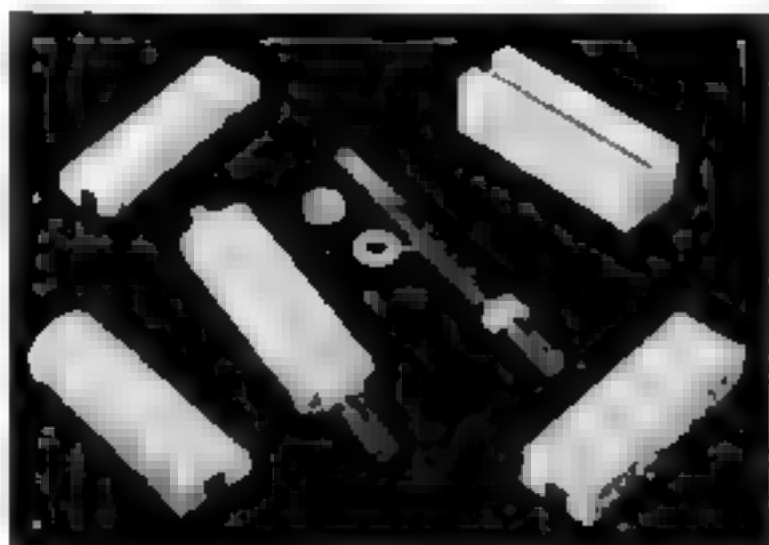
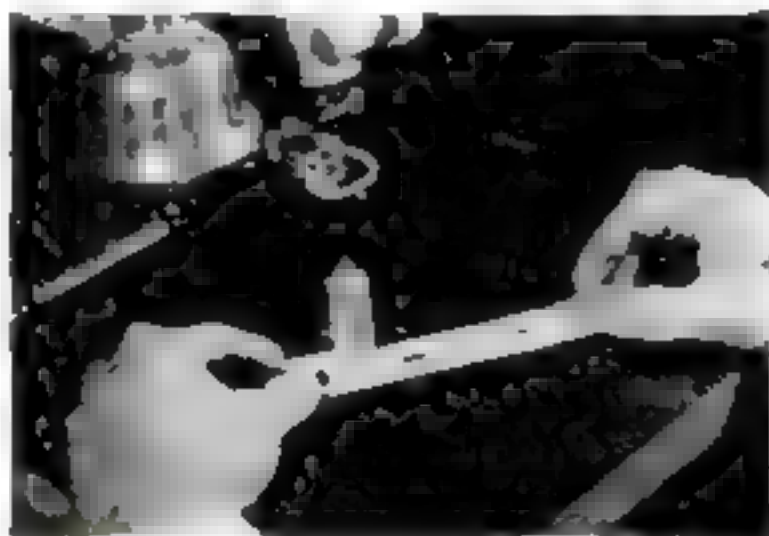
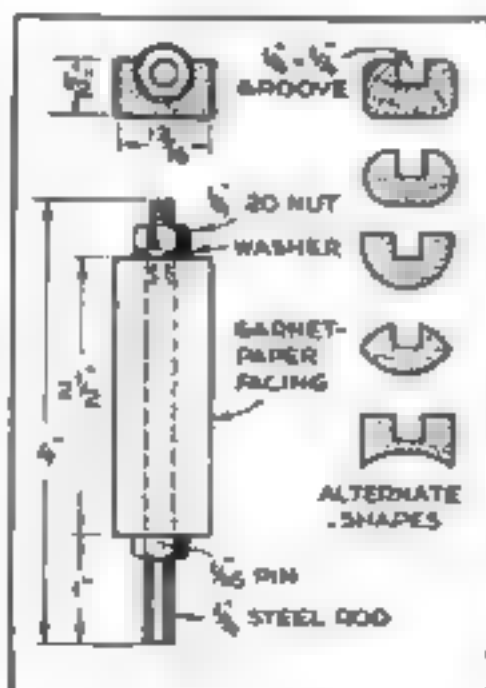
Of what use is a miter-joint clamp? This clamp consists of a block of wood squared and rabbeted on two sides to form flanges to fit into the rabbets of picture-frame molding. It is screwed to a base board. The mitered ends of molding are brought together against the block, secured with hold-down blocks, and locked by means of the C-clamps. Such a corner can then be nailed without danger of slipping. Pad the blocks when nailing carved moldings.

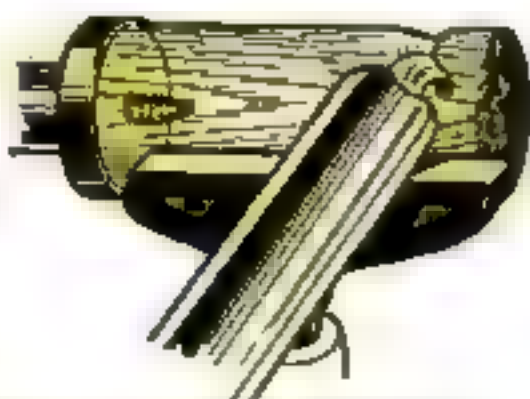
Shaped Blocks on Jigsaw Speed Sanding of Novelty Pieces

SANDING novelty craftwork can be made a quick, pleasant operation if you equip your jigsaw with sanding blocks of various shapes and a holder like that shown in the drawing and photos. It is a good idea to make three of each of the shapes shown for three different grades of glued-on garnet paper. Then, when sanding is to be done, you can change quickly to the contour and grit required for the particular job at hand.

If you have a circular saw, cut the $\frac{1}{4}$ " by $\frac{1}{4}$ " groove on a long strip; then cut the strip into three-block lengths. In this way you can save time by being able to shape three blocks in one operation.

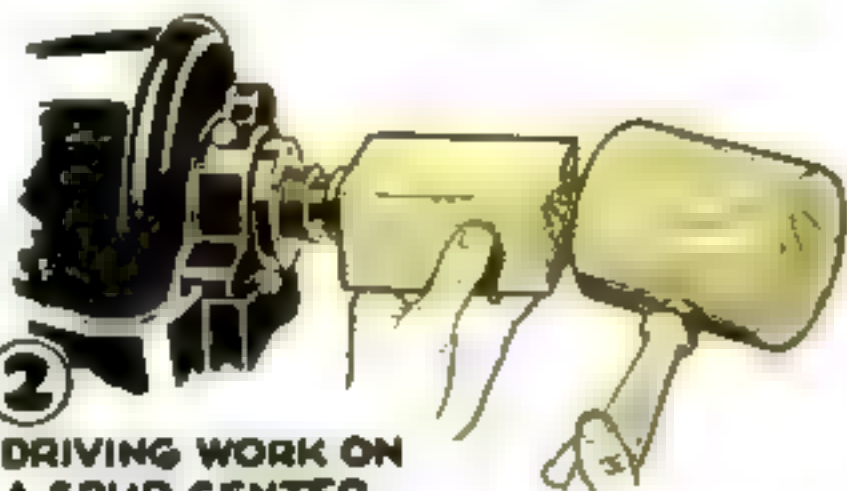
The holder is $\frac{1}{4}$ " drill rod threaded $\frac{1}{4}$ "-20 at one end for the space of 1". Drill out the threads of one nut, fit it on the rod, and drill through for a $\frac{1}{16}$ " pin, as indicated in the drawing—G. A. W.





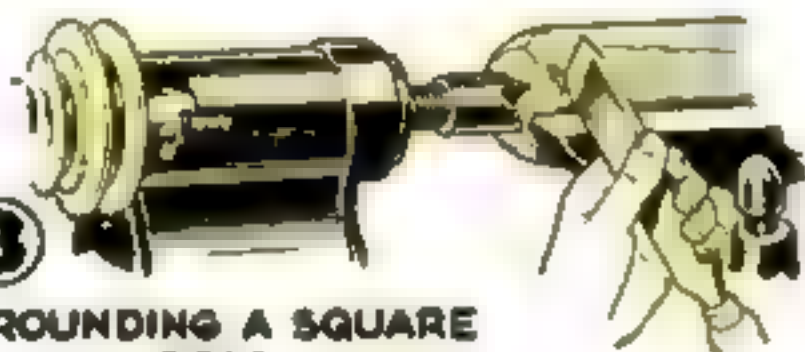
①

TURNING A CANDLESTICK



②

DRIVING WORK ON A SPUR CENTER



③

ROUNDING A SQUARE BEAD



④

LOOSENING AN OUTBOARD FACEPLATE

What's Wrong?



⑤

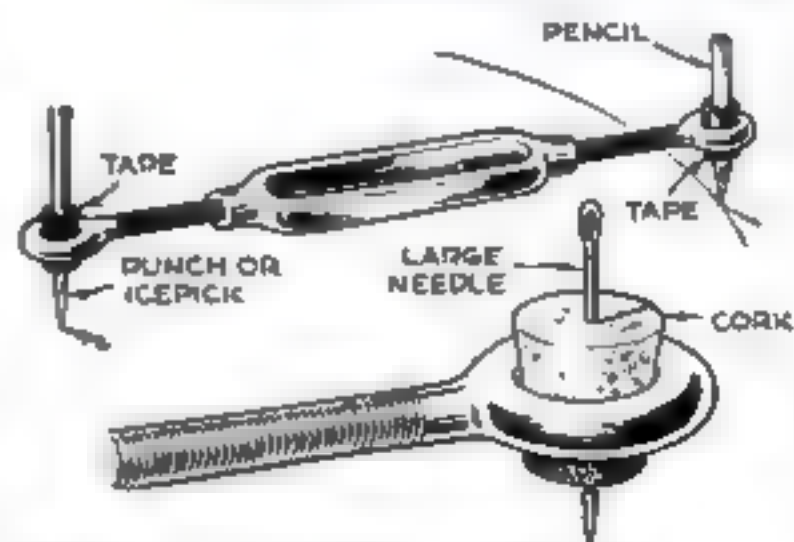
SANDING INSIDE OF BOWL

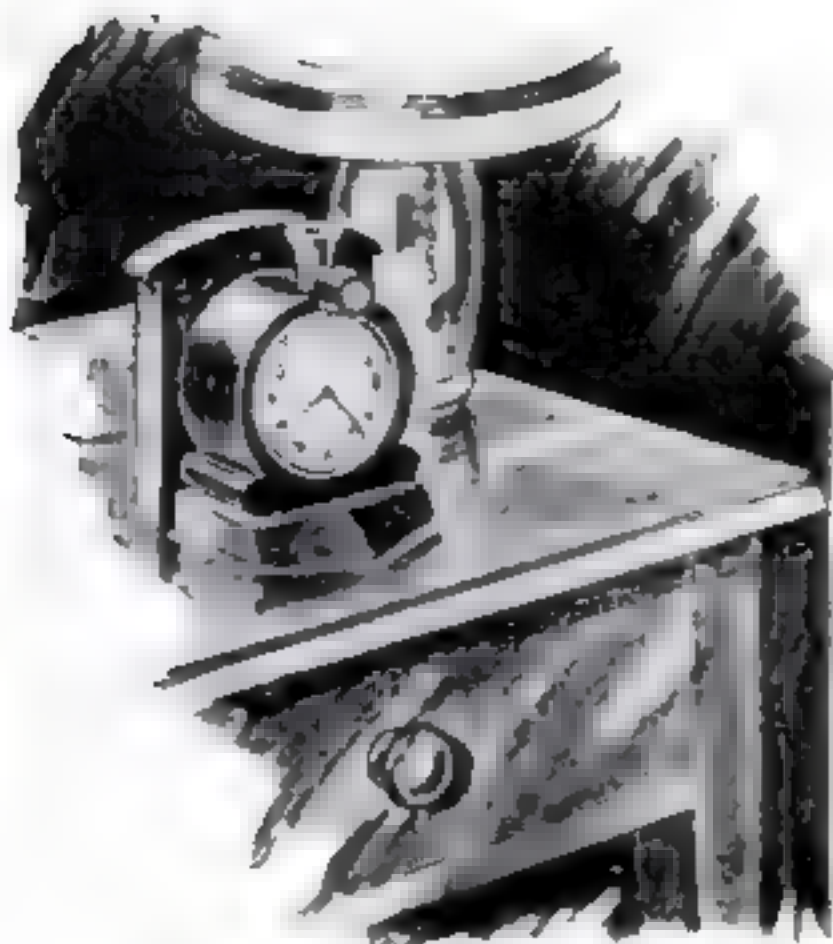
Can you spot the five errors in wood turning shown here?

1. For a turning as long as that shown, use a spur center and support the piece with the dead center. 2. To avoid bearing damage, remove the live center and drive it into the work. 3. The toe or long point of the skew should rest on the tool support. 4. Wrench pressure against the indexing pin may bend the pin. 5. A dangling necktie is dangerous. Tuck it in or leave it off.

Turnbuckle Serves as Compass for Drawing Large Circles

WHEN large circles are required in a layout and a beam compass or dividers adequate for the task are not available, an ordinary turnbuckle can be put to good use. Adjust it to the desired radius and insert a punch in the pivot end and a pencil in the other. Tape may be wound on these for better accuracy, or corks put in the holes and big needles pressed through.—BENNETT LEWIS.

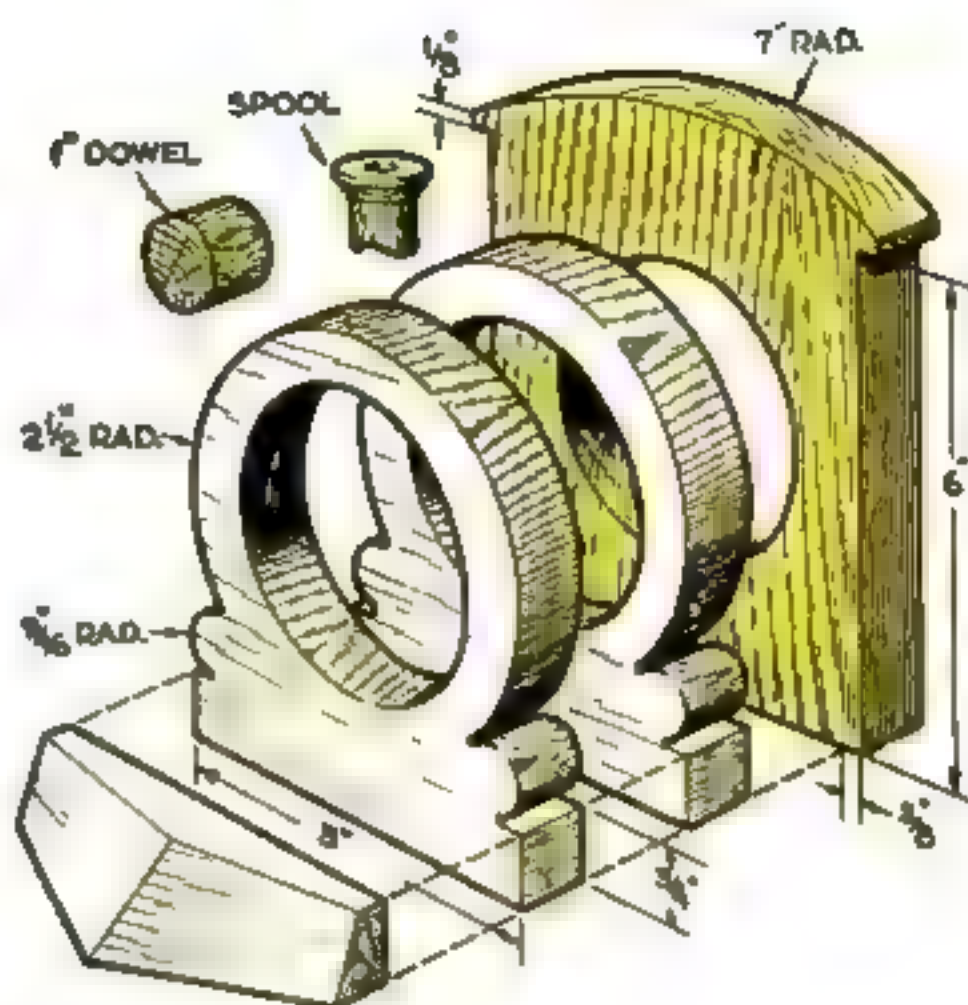




Engine Case Spruces Up Old Clock for Boy's Room

THAT old clock that outlived its Victorian case ticking away the days and years for your grandfather and father can be brought out of attic storage and given a novelty dress to serve your son. A few scraps of wood made into a locomotive case will be decorative in any boy's room.

Use $\frac{1}{4}$ " stock, and taper the piece for the cowcatcher as shown in the drawing. The two intermediate pieces can be cut quickly on a jigsaw, but a circle cutter and a scroll saw will do a satisfactory job.



Change the outside radius if the clock used occupies more space than the average alarm clock, and be sure to provide sufficient clearance for the winding key. Saw out the back piece and glue the parts together under pressure. Then glue on the spool smokestack and dowel headlight.

Hardwood can be stained or varnished, but soft wood should be enameled or lacquered. Wedge the clock in with bits of cardboard and hold it with a setscrew put in from the bottom.—JEANNE A. REYNAL.

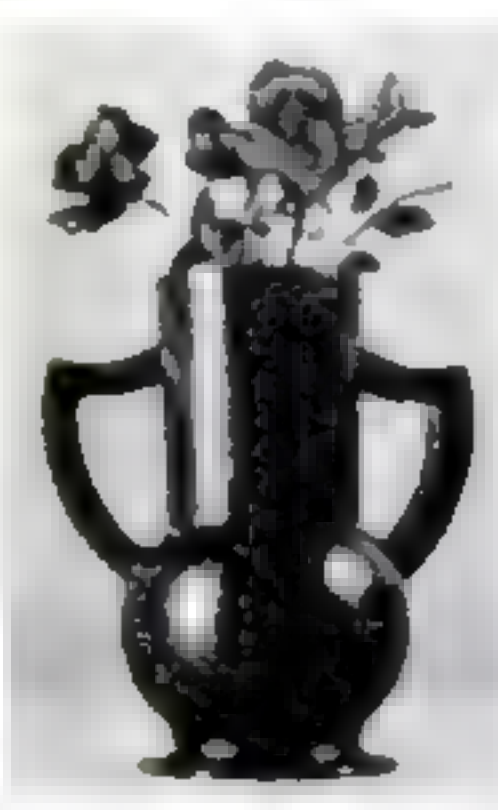
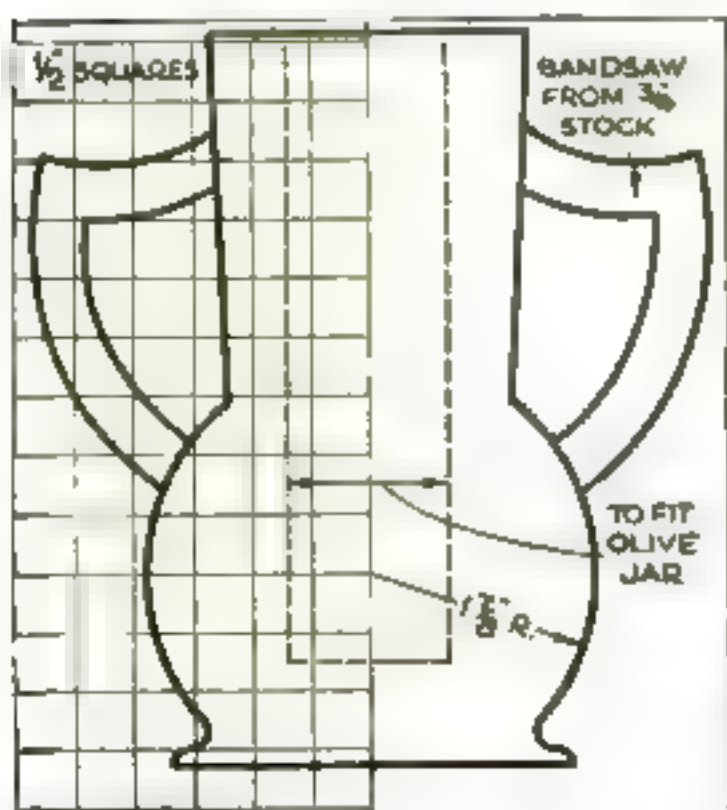
Out-of-the-Ordinary Wooden Vase Is Lathe-Turning Project

DESCENDED from the potter's wheel, the lathe rivals that ancient tool on its own ground with this juglike vase made of pine. Wood turners will find this project a little

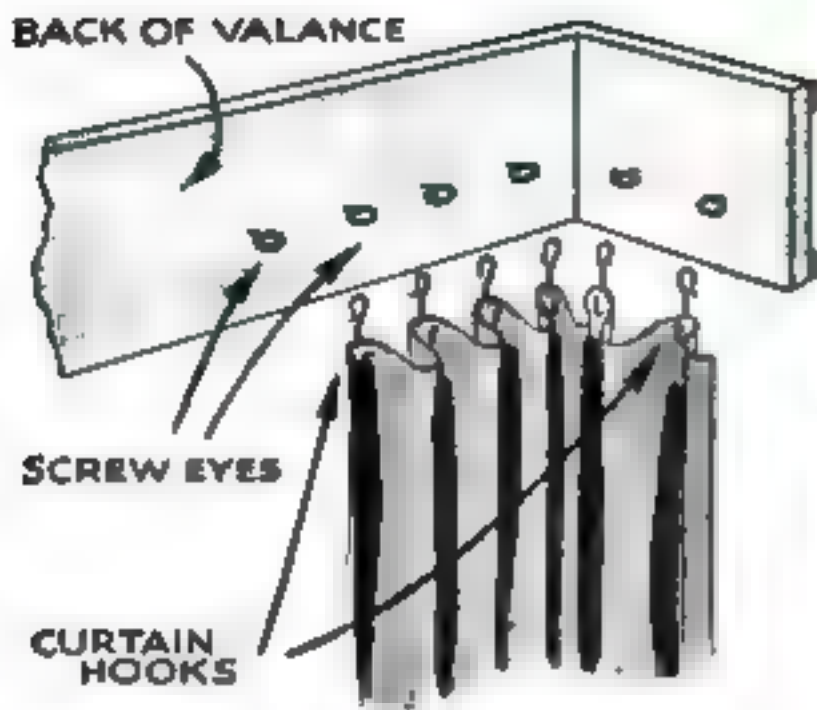
off the beaten path. The body of the vase is turned from a 4" by 4" by 7" turning square to the shape shown in the drawing. Then, with the body mounted on the faceplate,

hollow out the core to accommodate a glass olive jar, which you will find to be about 1 1/2" in diameter. The handles are jigsawed from $\frac{3}{4}$ " stock, sanded smooth, and glued to the body with dowels in the joints.

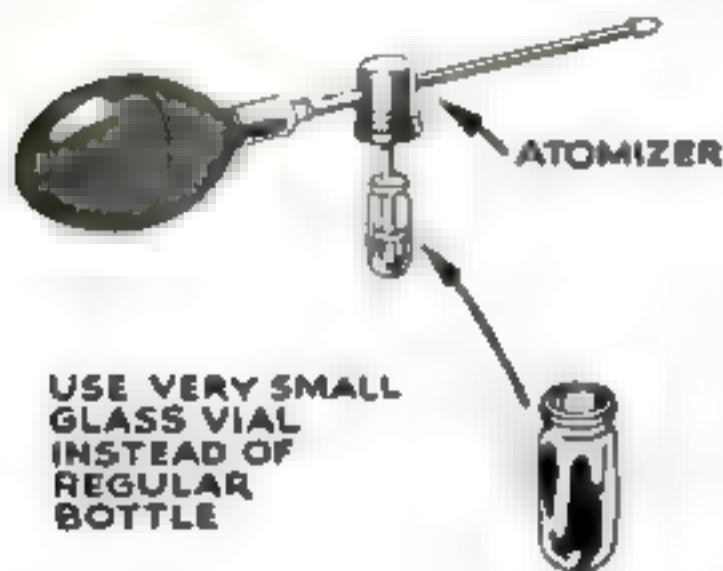
To obtain the lustrous black finish shown in the photo, dissolve nigrosine in alcohol and then mix it with shellac. Apply three coats, rubbing between coats with fine steel wool. A pad of blotting paper or felt should be glued to the bottom.—WILLIAM FREEMAN.



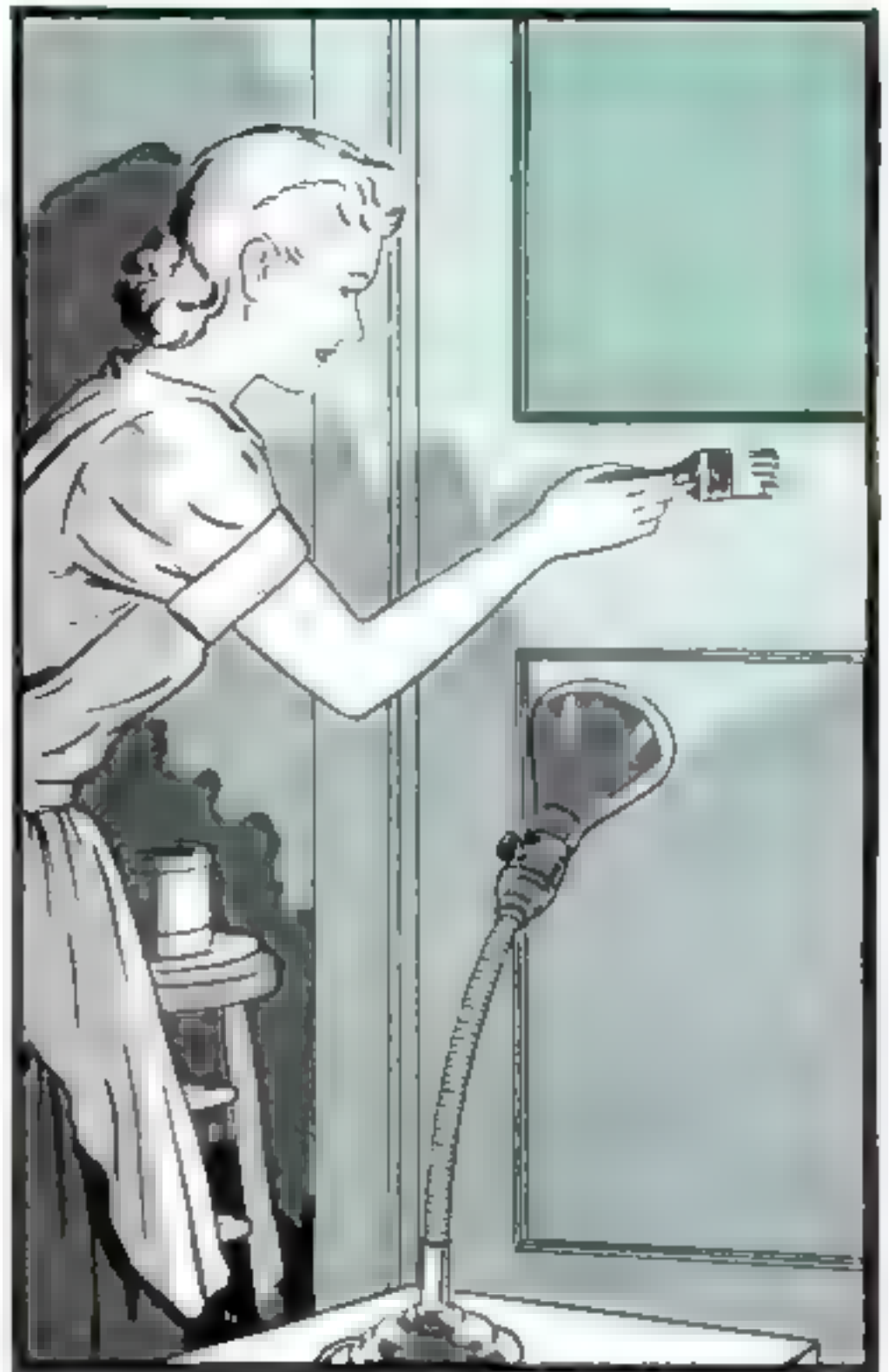
KEEPING



Where wooden valances are used, they serve as curtain rods as well if you put in screw eyes, as shown above, and hang the curtain hooks in them. Space the eyes to suit the drape pleats and also use two at each end.



When a drug is used in an atomizer for only a few applications, put it in a small glass vial that can be slipped over the atomizer feed tube. This saves cleaning out the large atomizer bottle. The same stunt is useful if so little liquid is left that it won't reach to the height of the intake tube in the jar.

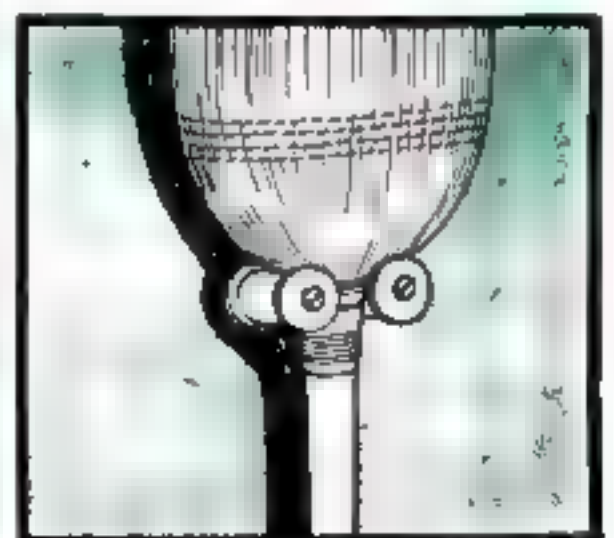
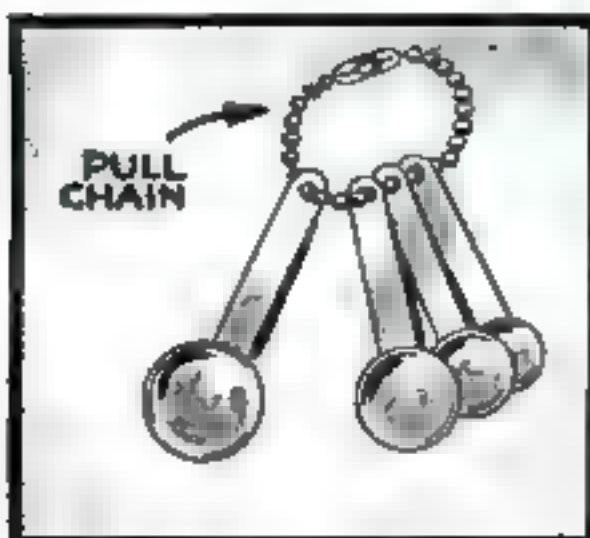


Extra light can be provided in corners or on dark walls and ceilings for pointing and papering jobs with the aid of an old gooseneck desk lamp. Remove the original shade and use a reflector-type bulb for best results.

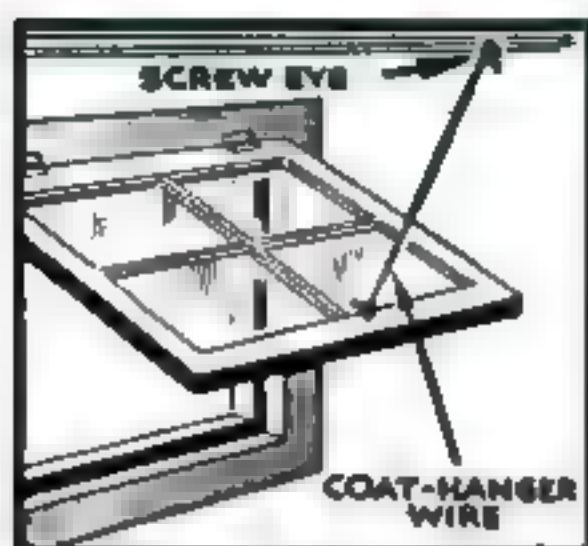
If you find the ring on a set of measuring spoons awkward because of its small size, discard it and string the spoons on a loop made from a switch pull chain.

Screw-top jars that are hard to open will turn readily if you use sandpaper for a grip. Have the paper large enough to fold over the sides. An old piece will do.

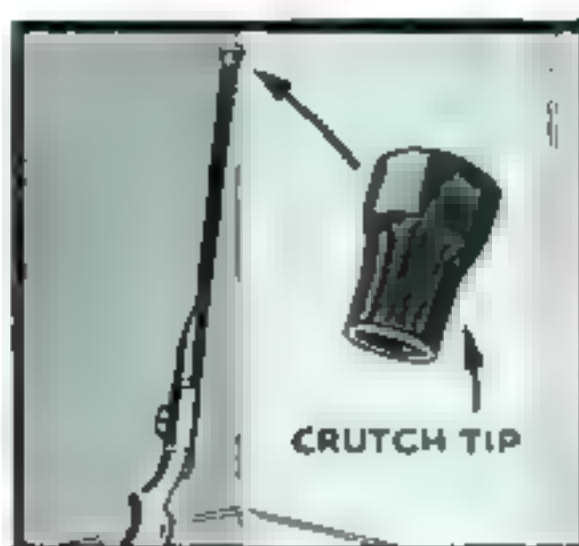
Two large empty spools nailed or screwed to the wall or a closet door make a firm bracket holder for a broom. Put them 2" apart so the handle will slip between.



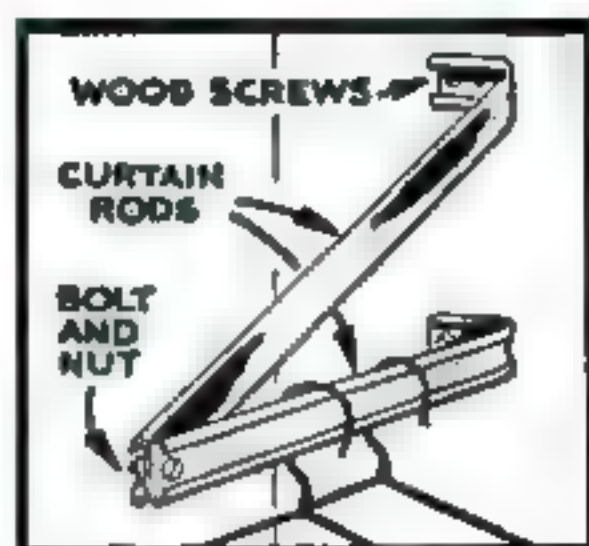
THE HOME SHOPSWAP



Wire coat hangers have many uses besides that originally intended. Bent into a hook and inserted in screw eyes, wire from one will hold a cellar window up.

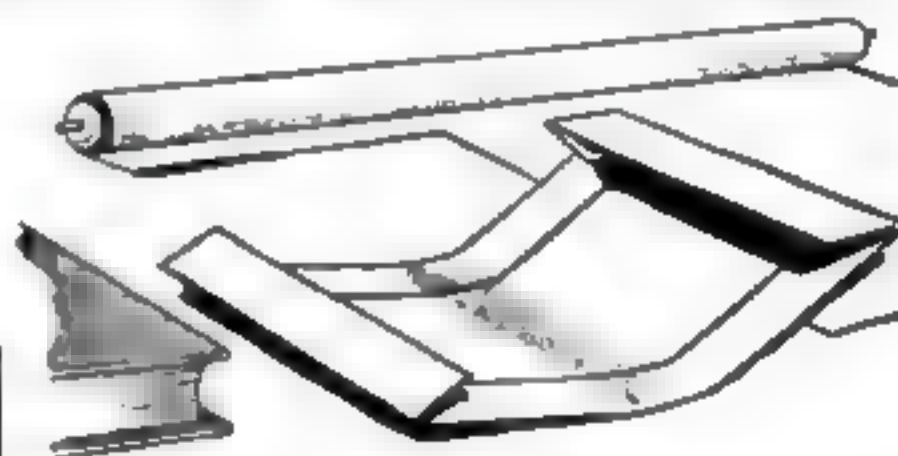
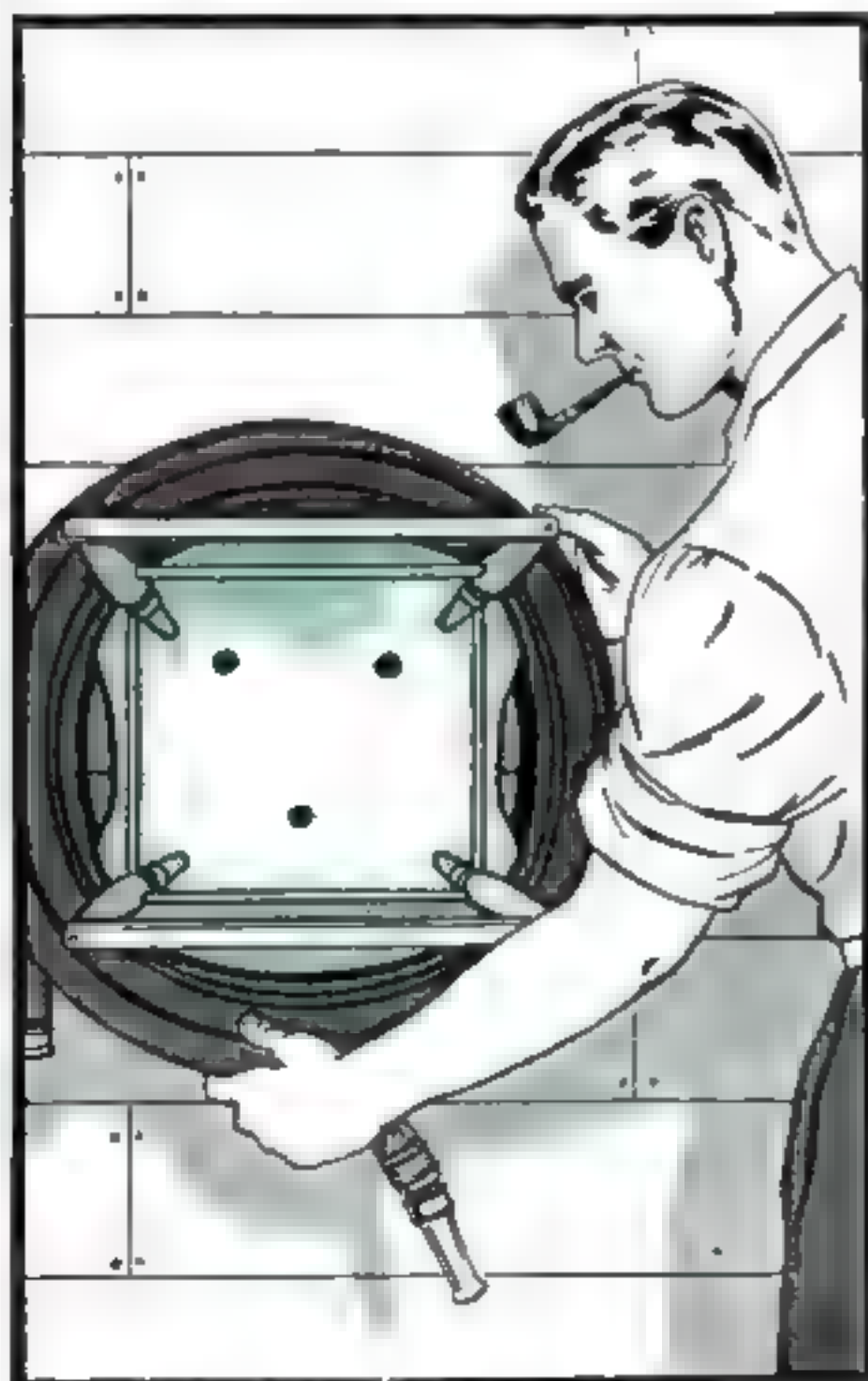


When storing a large-caliber gun such as a shotgun, slip a rubber crutch tip on the muzzle to keep out dust, lint, and small objects. Be sure the rubber tip is clean.



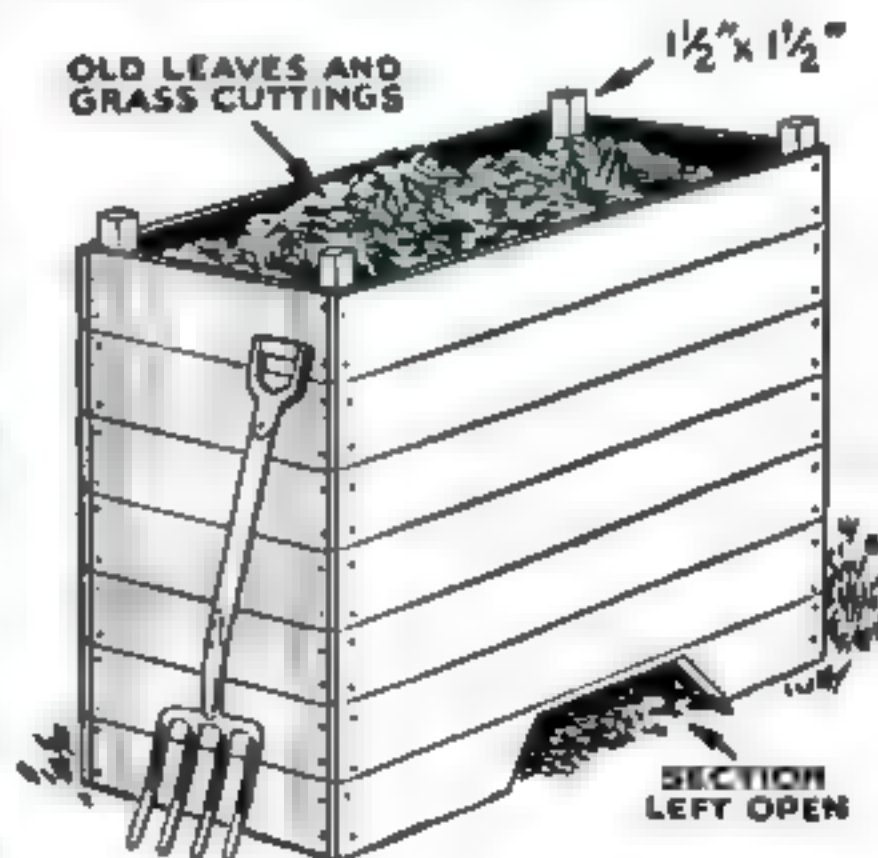
Space in a clothes closet where a rod won't go may be utilized if you bolt and screw up the halves of a curtain rod as shown. This accommodates six hangers.

Garden-hose deterioration can be prevented and you can still have the hose near a garden water supply if you provide a rack out of the sun in the tool shed or on the garage wall. One type of rack can be made from the bottom part of an old kitchen chair with guards nailed on as below.



Stiff fabric cut from an old window shade makes excellent book jackets. Fold rectangles as shown to fit the books and tuck the ends in the covers.

Compost piles are often harder to take material from than to add to. This box has an opening in the bottom from which rotted leaf humus can be removed in spring. It can be made of lumber as shown, or packing boxes minus their tops and bottoms can be assembled with hooks and eyes.





Seagoin' Jeep

SCALE MODEL OF OUR ¼-TON AMPHIBIAN, GRIZZLED VETERAN OF NUMEROUS INVASIONS

By John J. Gallivan

BABY brother to the familiar jeep, our Army's ¼-ton amphibian (Model GPA) can do almost anything that its older relative can—and then some. The jeep, of course, performs amazing deeds of derring-do over a variety of terrain and even defies gravity by taking off and flying for a second or so at a time, but it can't, alas, swim. So the seagoin' jeep was conceived.

This vehicle has a scow-shaped, water-tight body and is equipped with a propeller and a rudder. The rudder is coupled to, and works continuously with, the steering wheel; so the sole thing that need be done by the operator when going from land to water is to pull on a propeller-engaging lever that is located near his right hand. He doesn't even have to come to a stop to do this. For operating in rough water, there

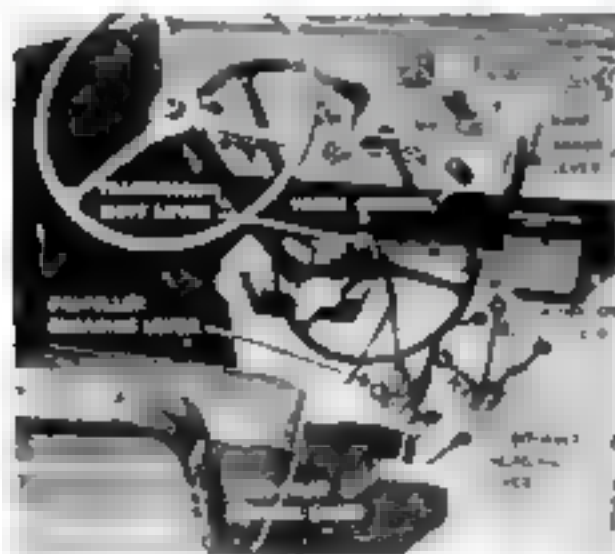
is a hinged spray shield on the foredeck that can be swung forward for protection. A spare wheel is carried in an accessible spot on the afterdeck. All of the seat cushions are removable and can be used for life preservers if mischance or enemy fire makes it advisable to abandon ship.

There is a power winch on the forward deck. If the amphibian gets mired in mud or is faced by a steep, slippery bank, a line is passed around a convenient tree or other strong anchor and around the winch; then the winch is engaged and the jeep pulls itself out of trouble. This winch is also useful when another vehicle gets bogged down, for then the amphibian can come to its aid.

With a wheelbase of 84" and an over-all length of about 182", the little hybrid weighs approximately 3,400 lb. It can carry an 800-lb. payload in addition to its own equipment and, thanks to its sturdy four-cylinder,

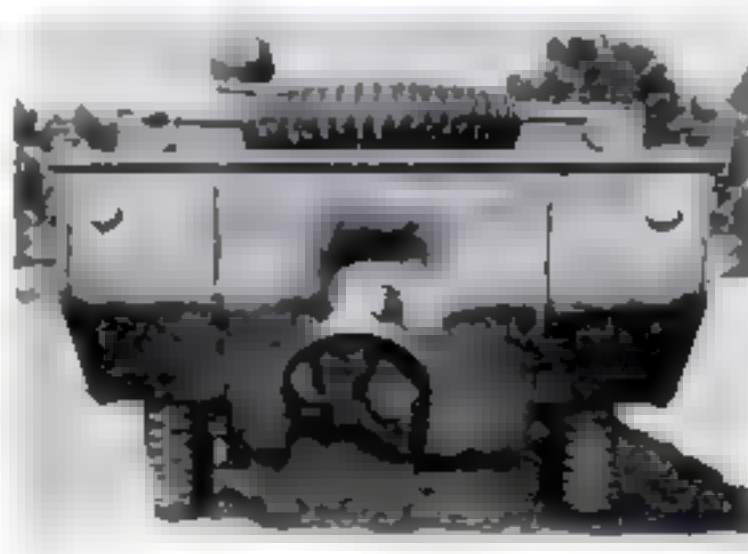


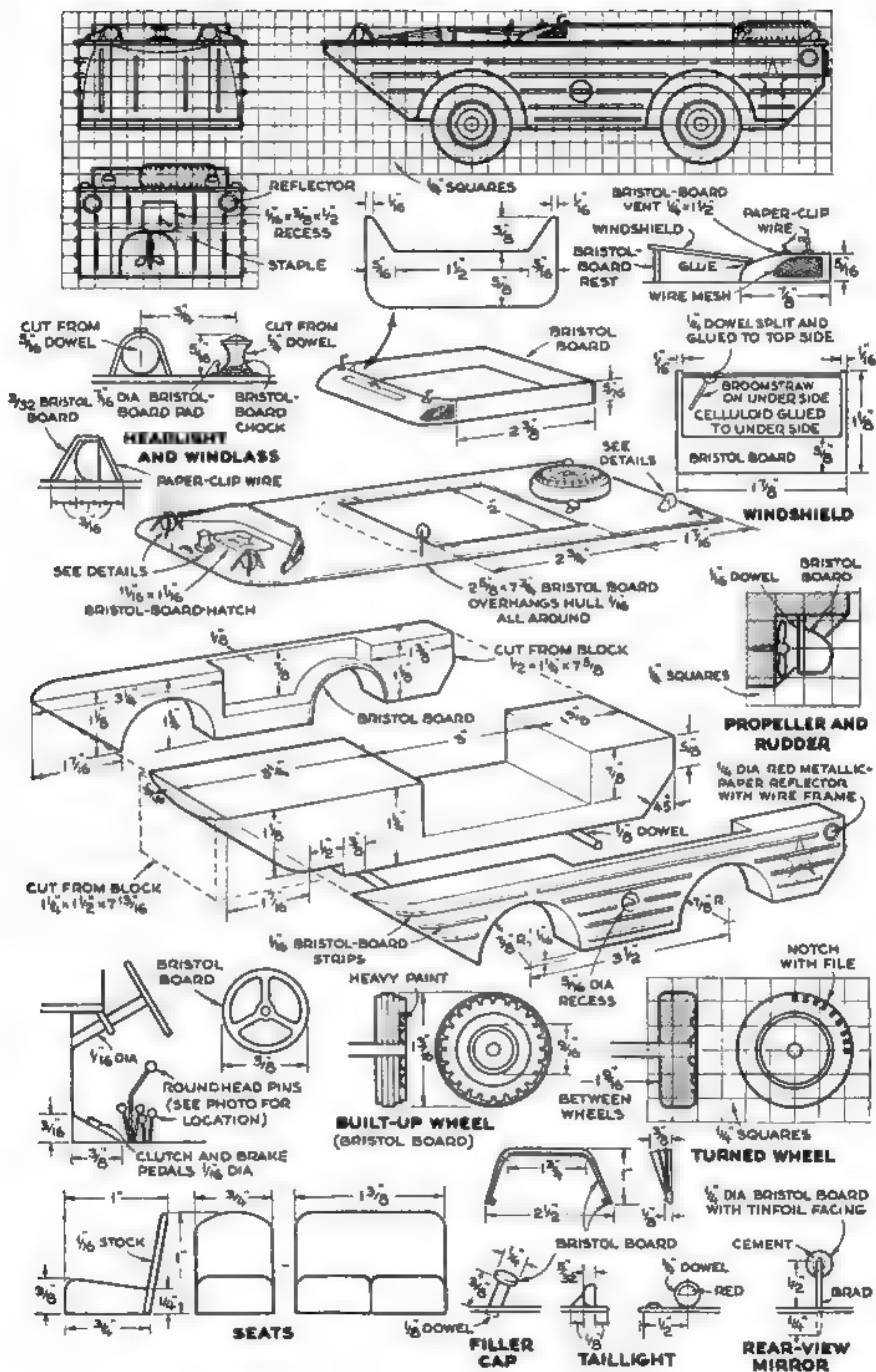
Especially good for scouting missions in enemy territory, the amphibious jeep carries five men and is capable of about 60 m.p.h. on good roads.



All controls are brought to the operator's seat. The jeep can be launched without having to pause just by manipulating the propeller-engaging lever.

Tucked under the rear end and set a little to left of center are the rudder and propeller. The former is coupled to and moves with the ground steering controls.





60-hp. engine, can carry that load at a speed of about 60 m.p.h. over good roads.

The model is constructed to a scale of $\frac{1}{2}$ " to the foot. This size is large enough so you can go into sufficient detail to make the work extremely interesting, yet it isn't so large that it will be unwieldy.

Three wooden blocks are used in making the body, as shown in the accompanying perspective drawing. Round off the face of the center block to give a duck-breasted effect; then cut the top front face off square $\frac{3}{16}$ " back from the edge. Shape the two outer blocks along the forward outboard edges to carry out the duck-breasted contour. After jigsawing the semicircles in these pieces to take the wheels, line the two after ones with Bristol-board mud shields, gluing them in place. Bore a $\frac{5}{16}$ " recess in the outboard face of each outer block and glue a bit of Bristol board in each recess to simulate a toe hold.

Make the deck from Bristol board. Note that it overhangs the body $\frac{1}{16}$ " all around. Fashion the lights, winch, hatch, chocks, rear-view mirror, and filler cap from bits of dowel, Bristol board, paper-clip wire, tin foil, and red metallic paper, as indicated in the details, and glue them in place. Assemble the cockpit coaming from wood and Bristol board. A small piece of wire mesh is cemented to each end of the wooden part of the coaming to give the effect of a screened ventilation-duct opening.

The windshield is made of celluloid and framed with Bristol board. A broomstraw and a split dowel, glued to the celluloid, serve to simulate a windshield wiper. The after end of the windshield is glued to the cockpit coaming and the forward end rests on two Bristol-board supports, which are cemented to the deck. Atop the coaming are mounted ventilation controls, which are fashioned from paper-clip wire and Bristol board.

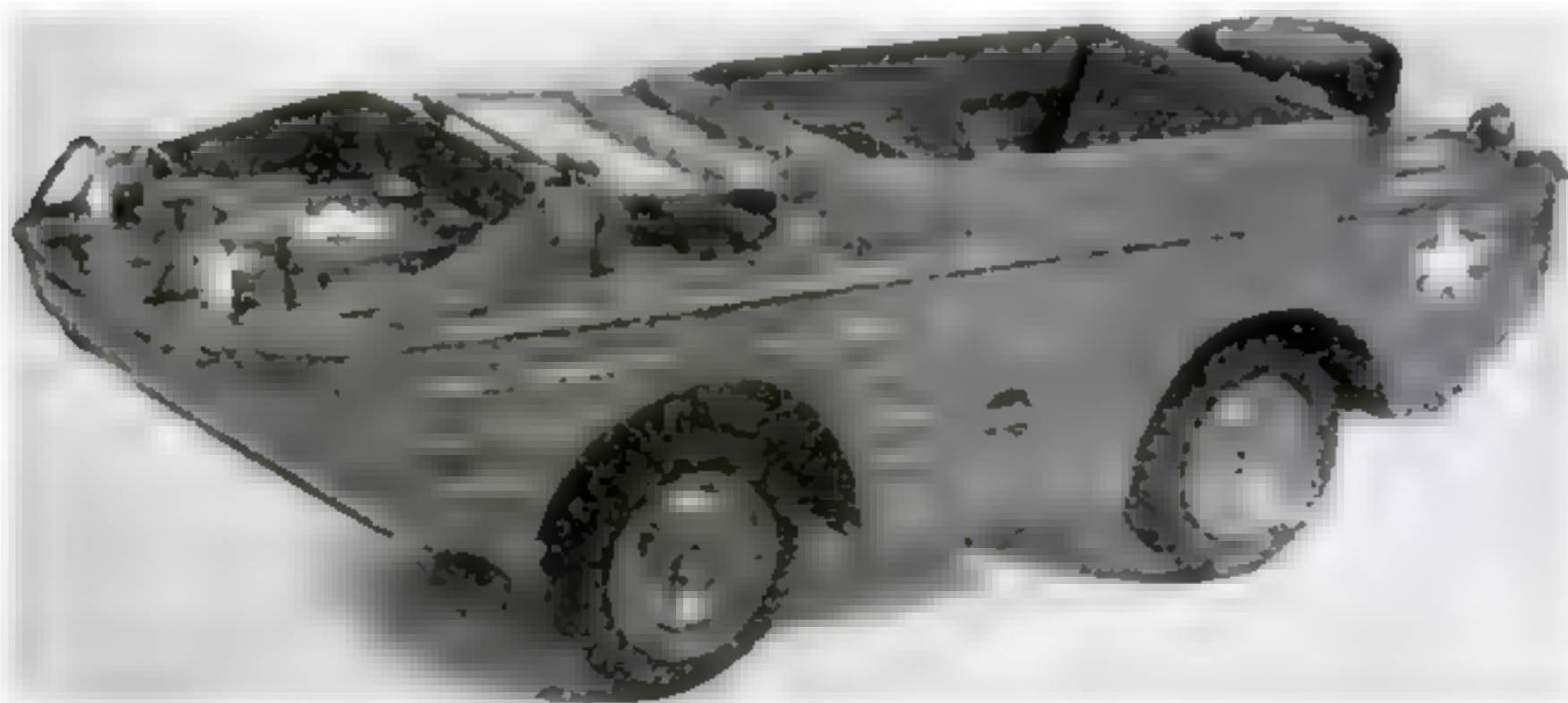
You can turn the five wheels in your lathe, but if turning facilities are not available, make the wheels from several glued-up Bristol-board disks. To cut these disks

quickly, clamp a razor blade in a draftsman's ink compass, set the compass to the proper radius, and scribe out the material. Be sure to use a new blade, since an old one may not produce a smooth cut. After gluing the disks together, round off the edges somewhat by sanding them.

The axles are lengths of $\frac{1}{8}$ " dowel. They are glued to the body and four of the wheels are glued to them. The fifth wheel is cemented to the after deck. Bristol board, as shown in one of the details, is used when making the spray shield that rests on the forward deck. Carve two single seats and one double one from wood and glue them in the cockpit. The two single ones go in front. Just forward of the left-hand front seat, install the controls. These consist of a steering wheel, which is built up of Bristol board and doweling; five shift levers, which are roundhead pins; a footboard, which is a $\frac{3}{16}$ " by $\frac{3}{8}$ " by $2\frac{1}{4}$ " triangular wood block; and clutch and brake pedals, which are cut from $\frac{1}{16}$ " doweling. A control panel may be simulated with hand-drawn dials and a few rounded bits of dowel glued to the dash.

Cut two recesses in the after end of the main body block—one for the propeller and the other for a towing hook. Dimensions for these recesses can be taken off the rear view and the propeller and rudder detail. The towing hook is simply a staple that is stuck part way into the body. The rudder is made from Bristol board and has a dowel stock. You can purchase the propeller, which is $\frac{1}{2}$ " in diameter, from a model-supply store.

Make the four safety reflectors from red metallic paper and put them in frames made from thin wire; then cement each one in its proper place on the body. Assemble the model and do any final sanding that may be necessary; then glue $\frac{1}{4}$ " Bristol-board rub strips to the body, as indicated. Finish with one or more coats of olive-drab quick-drying airplane dope. Paint the tires flat black. The stars can be decalcomanias or white-paper cutouts, or you can paint them in place, using a homemade stencil as a guide.



IF YOU HAVE NO SQUEEGEE, one can be made from a windshield wiper blade and a piece of hardwood $\frac{3}{4}$ " by $2\frac{1}{4}$ " by 8". Saw a slot along the center of one edge of the wood just wide enough so the metal back of the blade can be forced in. Reduce the thickness of the wood to $\frac{1}{2}$ " for about $1\frac{1}{4}$ " back from the slotted edge, and round the edges adjacent to the slot. Wet the wood, dry it with a flame, and sand off the roughness that results, repeating once or twice. This keeps water from making the wood rough when it is in use. Cut the blade to proper length, fill the slot with waterproof glue, and press in the blade.—W. E. B.



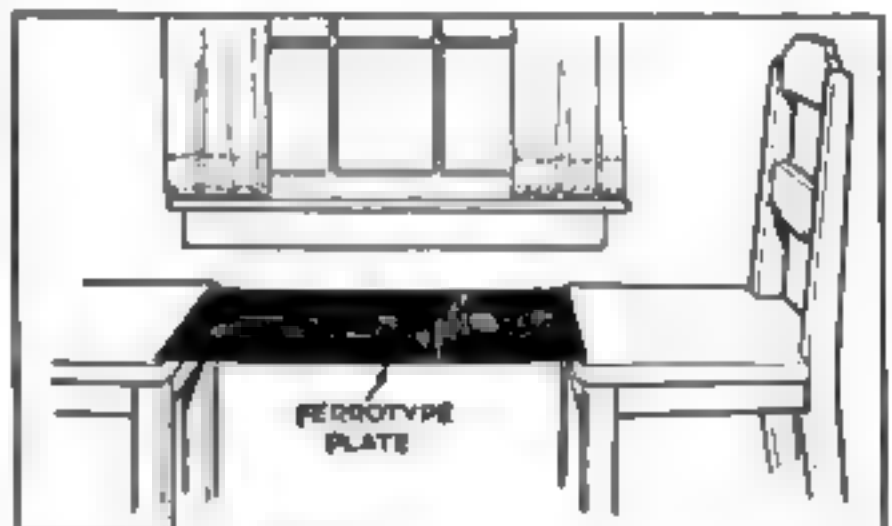
DEVELOPING TANKS of the type shown below, which normally accommodate a dozen cut films, can be used to develop twice that number at one time if two films, placed back to back, are loaded in each of the grooved slides of the tank. In order to keep the films from sticking together, place one of the black paper separators that come with the film between each pair, as indicated in the illustration.—LOUIS HOCHMAN.



SHOULDER STRAP SLIDES such as are used on women's clothing permit quick adjustment in the length of a light-meter neck ribbon, lessening the chances that it will become tangled. Sew two slides to the ribbon

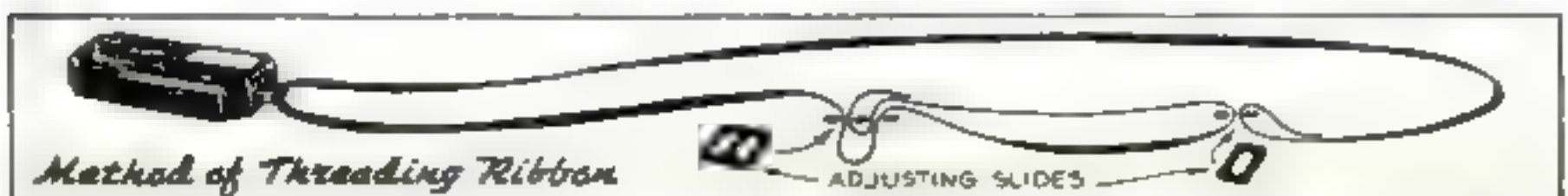


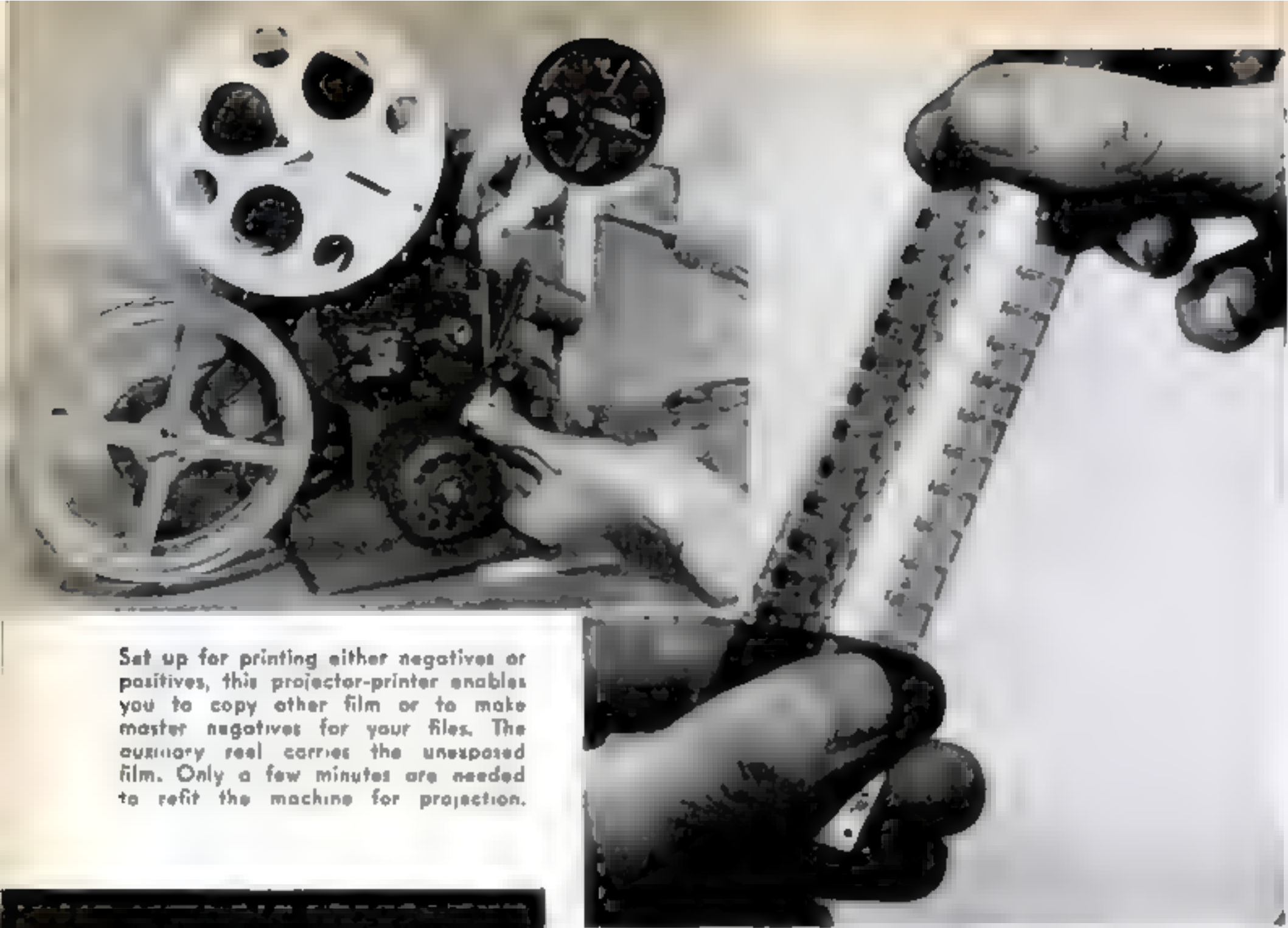
CROPPING NEGATIVES too big to fit into the enlarger is facilitated by using a clear negative of the appropriate size as a guide. You can thus see exactly what the area includes, and so get the composition you want. The procedure works equally well for contact printing when you want to eliminate undesirable parts of a negative in these days of printing-paper shortages.



PRINTS DRY QUICKLY if the ferrotyping plate on which they have been squeegeed is placed upside down across two chairs, as above, in full sunlight near a window. The black back of the plate absorbs heat from the sun, and the prints dry within a few minutes. Spread a newspaper to catch the prints as they fall.—KEN MURRAY.

in the same way they would be attached to garment straps. The ribbon then can be adjusted to allow the meter to hang normally from the neck to the breast pocket. A quick shift allows full-length use.—L. J. S.





Set up for printing either negatives or positives, this projector-printer enables you to copy other film or to make master negatives for your files. The auxiliary reel carries the unexposed film. Only a few minutes are needed to refit the machine for projection.

PRINTING HOME MOVIES WITH YOUR PROJECTOR

By Ervin Walters

IS THERE a picture in a friend's film library that you wish were yours? Would you like to have master negatives of your home movies from which to print sequences for exchange with other amateurs, for distribution among friends and relatives, or as insurance against loss or damage to a prized reel?

With a homemade accessory, you can convert your projector for printing copy negatives and positives and still have it available for giving shows to entertain your guests. The added expense for movies made this way is almost negligible—only the cost of the extra positive film, which is the kind used for preparing both the negative and positive strips, plus a few cents for developing chemicals. But as a result you will have both a positive film and a master negative from which you can make any

number of additional prints that you wish.

A negative roll can be edited, spliced, titled, chemically bleached for fade-ins and fade-outs, and otherwise modified; then the print made from it will be all in one piece—with no splices to come apart. Special effects such as double exposures with a title superimposed on a scene can be produced. When desired, the negative can be inserted in a miniature-film enlarger and the image of a frame can be transferred directly to enlarging paper, thus providing a paper print without an intermediate transparency.

The exposure latitude of negative movie film is much greater than that of a film that is to be reversed and used as a positive. You can, for example, intensify or reduce the negative after its development or vary the light or exposure time during subsequent printing. Since a negative strip will generally require shorter exposure than one to be reversed—as much as a whole stop

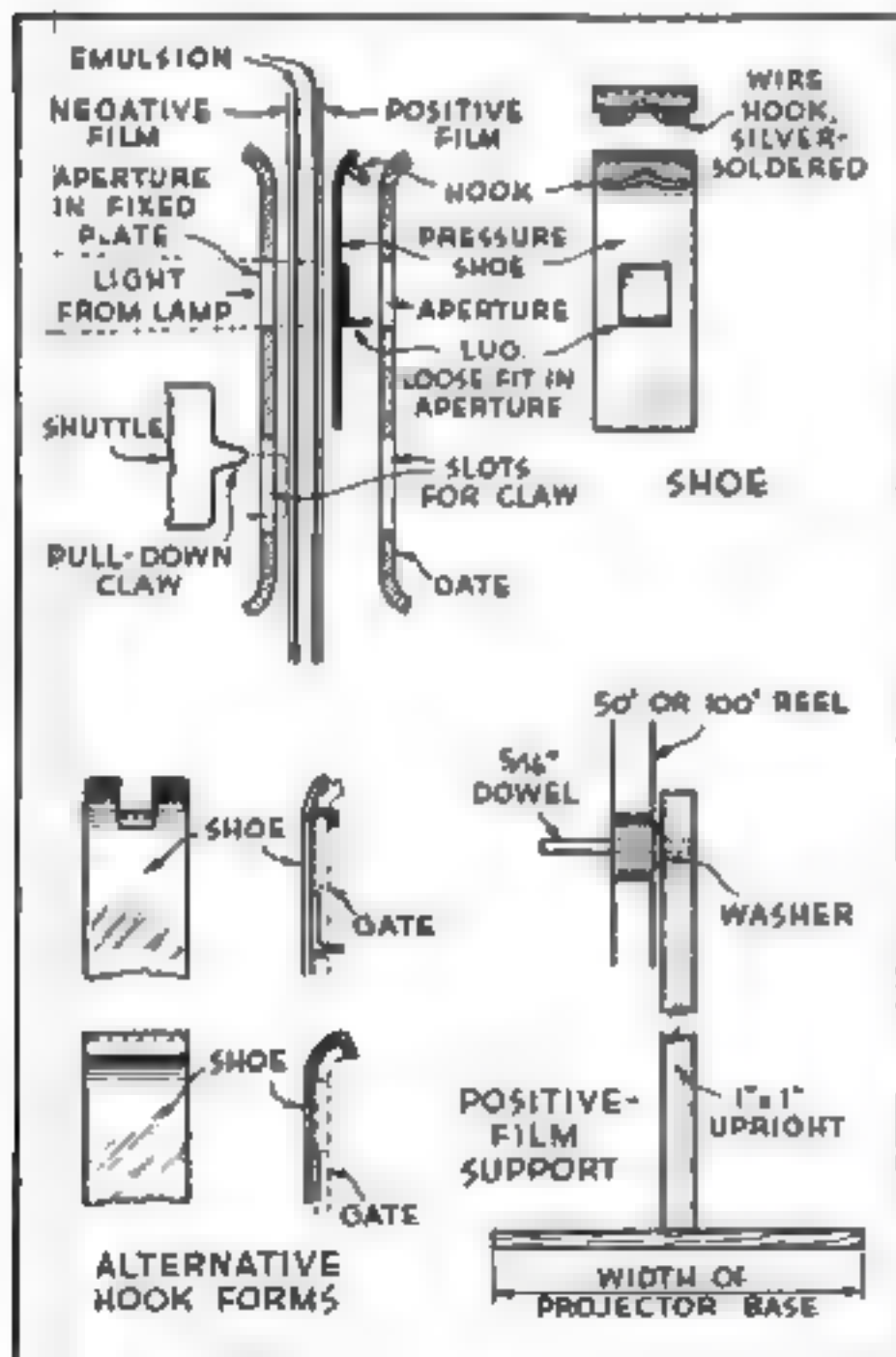
on the lens-aperture scale—in some cases the negative-positive process will produce a usable picture when there is not enough light for the same film to be developed and reversed.

Reversal film produces fine-grain images; but if you use the right developers and reasonable care, equally fine grain can be obtained with the negative-positive method. In processing the negative strip, use a soft-working, fine-grain developer of the type adapted to the film. Eastman D-76, Ansco No. 12, Gaevent GD-163, and DuPont ND-2 are among the suitable formulas. The positive should be processed in a developer that will give it sufficient snap. Follow the film manufacturer's recommendation, which will probably be something on the order of Eastman D-16, Ansco No. 20, Gaevent GD-158, or DuPont PD-1.

There are three main steps in converting a projector for printing. You will need a source of reduced illumination, an additional holder for 50' or 100' of film, and a pressure shoe for the film gate. The photos show how a DeVry Model T 16-mm. projector was converted. Another machine may require some changes in the method, but in no case should it be necessary to alter permanently or to damage the projector itself.

One way to arrange for reduced illumination is to remove the regular projector lamp and the top or side of the lamp house, and to install a new top or some other socket fitting. This should center a small lamp in line with the condensing lenses in the same relative position as the regular projector lamp. Louvers and other openings must be screened so that no white light escapes from the lamp house. One photo shows a 7½-watt white opal-glass lamp in a candelabra socket supported by a lamp-house cap made from sheet metal. The wires run up through a hole in the cap, and rubber tape wrapped around them on both sides of the metal hold the socket rigid. If a 7½-watt lamp is not bright enough, especially in a projector with a fairly high minimum speed, use a 10 or 15-watt lamp.

A flexible form of illumination can be provided with an automobile-headlight bulb mounted in the projector lamp house and connected to a transformer that delivers around 6 volts. The transformer should be of ample wattage, say 75 to 150. If it is a tapped type with a control lever, it can be adjusted to various voltages for regulating the brilliancy of the lamp. Otherwise a rheostat may be connected in series with one of the lamp leads. [Turn the page.]



Fitting the film gate with a pressure shoe, shown held in the hand in the photos above and below, assures good, even film contact and sharp images.



Auto bulbs are of clear glass, and a piece of opal glass will be needed between the lamp and the condenser lens of the projector to diffuse the light. Fine ground glass will serve if opal glass is not available. With such a diffuser, the lamp filament need not be accurately positioned with respect to the condenser.

The negative film or the roll being copied is carried on the regular projector reels and fed through in the usual way. A support for the reel carrying the film to be printed may be merely a wooden upright on a $\frac{1}{4}$ " or $\frac{3}{8}$ " plywood base that can be slipped under one end of the projector and held by the weight of the machine. About 2" from the top, drive in a $5/16$ " metal or wood peg so that it will extend outward $1\frac{1}{2}$ " or so and hold the reel in line with the projector gate. A washer between the reel and upright will reduce drag.

One secret of obtaining sharp images is to use a pressure shoe on the film gate. Without such a device the film strips, being supported only at the edges and being free to move slightly forward and backward when opposite the light aperture, will not always remain in contact over the entire frame.

The shoe may be made of a thin strip of metal fitted over the aperture in the gate, as shown in the drawings. On most projectors the gate is the part equipped with springs to hold the film in the plane of the projector-lens focus. A shoe must be designed to fit your particular projector, but at its upper end it can usually be provided with some sort of a hook that will engage the top end of the gate. It should also contain a lug projecting forward toward the projector-lens tube through the rectangular gate opening or aperture. On the shoe shown, the lug is L-shaped and fits rather loosely to keep the shoe from moving downward and to limit side movement.

Polish the film side of the shoe to absolute smoothness with fine abrasive cloth, buff it, and keep it always clean and polished. Reflection from the polished surface seems to have no bad effect on image quality.

Be careful not to design the shoe so it will be struck by the pull-down claws when the projector is running. The one shown does not extend quite to the slot through which the claw operates. For some projectors, it might be desirable to extend the plate over the claw slots and to cut similar slots in it.

If the shoe fails to provide good contact between film strips, a second pressure plate



This small opal-glass lamp gives light for printing. The metal cap supports it in the projector lamp house.

of glass over the aperture in the film-channel piece may help. The glass must, of course, have polished edges, and it must be kept clean. It is best, however, to get along without the glass if possible.

To use the projector for printing, thread the negative or the film being copied in the usual way with the emulsion side toward the lens tube, in which the lens may be left or removed as desired. Run 2" or 3" of the strip to be printed through the gate, emulsion side toward the other strip, turn the shuttle-control knob until the claws extend all the way through their slots, and move the two strips until their perforations engage the claws; then, with the pressure shoe in position, close the gate.

Set the projector rheostat for reduced speed, and operate the print-film reel by hand to relieve tension and eliminate drag and slippage. A few tests will enable you to adjust projector speed and light intensity for proper exposure. With practice you can make the settings after merely examining the negative or the film to be copied, and you can vary light or speed for different scenes as the films run through.

Direct the printed end of the strip being processed into a cardboard box or a cloth bag having a hoop opening or onto a take-up reel. Plug minor light leaks with adhesive tape so no stray light will strike the film.

**CAN YOU BEAT
THESE PICTURES?**

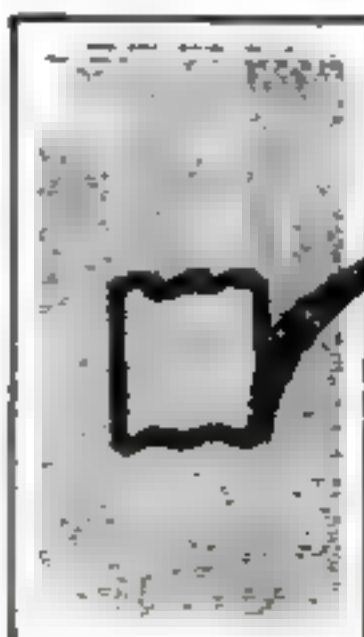
We will pay \$5 for any photo used on this page. Write your name and address on each print. Enclose a stamped, self-addressed envelope and the negative, if it is available, and send your contribution to the Curious Photos Editor.

BENJY, THE BASHFUL BEAR, is indeed a retiring fellow. He doesn't like humans gaping at him. When Henry Bugella, of Cicero, Ill., came along to snap his picture, Benjy hid his mug behind his paw. But over there at the right is Benjy's portrait just the same—a study in bashfulness that the contributor calls "Camera Shy." Or maybe we're wrong. Maybe a flea was troubling Benjy. Or maybe, catlike—if a polar bear can ever be said to be catlike—Benjy was just washing his face before posing.

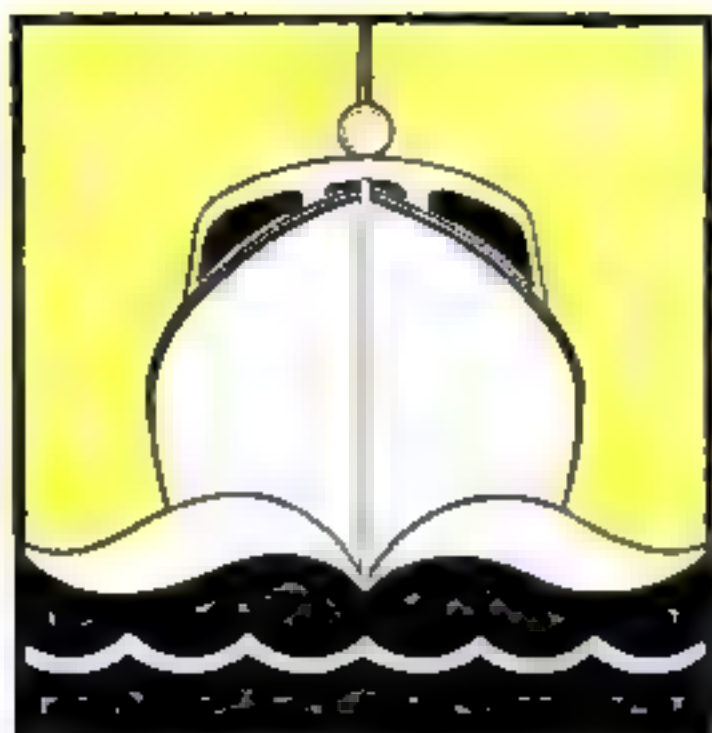


NO TEETOTALER is this squirrel, photographed having an exhilarating nip of root beer—or at least lovingly licking the mouth of the bottle some two-legged imbibor so thoughtfully left behind on a back-yard table. From the looks of things, particularly those paws getting such a firm grasp on the neck of the bottle, it seems likely to be a case of "bottoms up" at any moment. Stanley Goldsmith, of Pittsburgh, who took the picture, says the squirrel's mate has no use at all for such a drink and keeps steadfastly to a normal diet of acorns and nuts, as befits a dignified squirrel.

IS V-MAIL REALLY NEW? Homing pigeons transported an early form in 1871 during the siege of Paris in the Franco-Prussian War. Below is a reproduction of one of five of these old films, each about $\frac{1}{2}$ " x $1\frac{1}{2}$ ", owned by the Eastman Kodak Company. By photographic reduction, the content of several newspapers was reproduced on material weighing less than one grain. Since this was before modern film was invented, collodion stripped from wet plates was used. Each pigeon could carry 20 of the films rolled inside a quill the size of a toothpick. At their destination, the films were placed in water to which a few drops of ammonia had been added. Unrolled and dried, they were projected upon a screen and copied by clerks.



1891. 1892. 1893. 1894. 1895. 1896. 1897. 1898. 1899. 1900. 1901. 1902. 1903. 1904. 1905. 1906. 1907. 1908. 1909. 1910. 1911. 1912. 1913. 1914. 1915. 1916. 1917. 1918. 1919. 1920. 1921. 1922. 1923. 1924. 1925. 1926. 1927. 1928. 1929. 1930. 1931. 1932. 1933. 1934. 1935. 1936. 1937. 1938. 1939. 1940. 1941. 1942. 1943. 1944. 1945. 1946. 1947. 1948. 1949. 1950. 1951. 1952. 1953. 1954. 1955. 1956. 1957. 1958. 1959. 1960. 1961. 1962. 1963. 1964. 1965. 1966. 1967. 1968. 1969. 1970. 1971. 1972. 1973. 1974. 1975. 1976. 1977. 1978. 1979. 1980. 1981. 1982. 1983. 1984. 1985. 1986. 1987. 1988. 1989. 1990. 1991. 1992. 1993. 1994. 1995. 1996. 1997. 1998. 1999. 2000. 2001. 2002. 2003. 2004. 2005. 2006. 2007. 2008. 2009. 2010. 2011. 2012. 2013. 2014. 2015. 2016. 2017. 2018. 2019. 2020. 2021. 2022. 2023. 2024. 2025. 2026. 2027. 2028. 2029. 2030. 2031. 2032. 2033. 2034. 2035. 2036. 2037. 2038. 2039. 2040. 2041. 2042. 2043. 2044. 2045. 2046. 2047. 2048. 2049. 2050. 2051. 2052. 2053. 2054. 2055. 2056. 2057. 2058. 2059. 2060. 2061. 2062. 2063. 2064. 2065. 2066. 2067. 2068. 2069. 2070. 2071. 2072. 2073. 2074. 2075. 2076. 2077. 2078. 2079. 2080. 2081. 2082. 2083. 2084. 2085. 2086. 2087. 2088. 2089. 2090. 2091. 2092. 2093. 2094. 2095. 2096. 2097. 2098. 2099. 2100. 2101. 2102. 2103. 2104. 2105. 2106. 2107. 2108. 2109. 2110. 2111. 2112. 2113. 2114. 2115. 2116. 2117. 2118. 2119. 2120. 2121. 2122. 2123. 2124. 2125. 2126. 2127. 2128. 2129. 2130. 2131. 2132. 2133. 2134. 2135. 2136. 2137. 2138. 2139. 2140. 2141. 2142. 2143. 2144. 2145. 2146. 2147. 2148. 2149. 2150. 2151. 2152. 2153. 2154. 2155. 2156. 2157. 2158. 2159. 2160. 2161. 2162. 2163. 2164. 2165. 2166. 2167. 2168. 2169. 2170. 2171. 2172. 2173. 2174. 2175. 2176. 2177. 2178. 2179. 2180. 2181. 2182. 2183. 2184. 2185. 2186. 2187. 2188. 2189. 2190. 2191. 2192. 2193. 2194. 2195. 2196. 2197. 2198. 2199. 2200. 2201. 2202. 2203. 2204. 2205. 2206. 2207. 2208. 2209. 2210. 2211. 2212. 2213. 2214. 2215. 2216. 2217. 2218. 2219. 2220. 2221. 2222. 2223. 2224. 2225. 2226. 2227. 2228. 2229. 2230. 2231. 2232. 2233. 2234. 2235. 2236. 2237. 2238. 2239. 2240. 2241. 2242. 2243. 2244. 2245. 2246. 2247. 2248. 2249. 2250. 2251. 2252. 2253. 2254. 2255. 2256. 2257. 2258. 2259. 2260. 2261. 2262. 2263. 2264. 2265. 2266. 2267. 2268. 2269. 2270. 2271. 2272. 2273. 2274. 2275. 2276. 2277. 2278. 2279. 2280. 2281. 2282. 2283. 2284. 2285. 2286. 2287. 2288. 2289. 2290. 2291. 2292. 2293. 2294. 2295. 2296. 2297. 2298. 2299. 2300. 2301. 2302. 2303. 2304. 2305. 2306. 2307. 2308. 2309. 2310. 2311. 2312. 2313. 2314. 2315. 2316. 2317. 2318. 2319. 2320. 2321. 2322. 2323. 2324. 2325. 2326. 2327. 2328. 2329. 2330. 2331. 2332. 2333. 2334. 2335. 2336. 2337. 2338. 2339. 2340. 2341. 2342. 2343. 2344. 2345. 2346. 2347. 2348. 2349. 2350. 2351. 2352. 2353. 2354. 2355. 2356. 2357. 2358. 2359. 2360. 2361. 2362. 2363. 2364. 2365. 2366. 2367. 2368. 2369. 2370. 2371. 2372. 2373. 2374. 2375. 2376. 2377. 2378. 2379. 2380. 2381. 2382. 2383. 2384. 2385. 2386. 2387. 2388. 2389. 2390. 2391. 2392. 2393. 2394. 2395. 2396. 2397. 2398. 2399. 2400. 2401. 2402. 2403. 2404. 2405. 2406. 2407. 2408. 2409. 2410. 2411. 2412. 2413. 2414. 2415. 2416. 2417. 2418. 2419. 2420. 2421. 2422. 2423. 2424. 2425. 2426. 2427. 2428. 2429. 2430. 2431. 2432. 2433. 2434. 2435. 2436. 2437. 2438. 2439. 2440. 2441. 2442. 2443. 2444. 2445. 2446. 2447. 2448. 2449. 2450. 2451. 2452. 2453. 2454. 2455. 2456. 2457. 2458. 2459. 2460. 2461. 2462. 2463. 2464. 2465. 2466. 2467. 2468. 2469. 2470. 2471. 2472. 2473. 2474. 2475. 2476. 2477. 2478. 2479. 2480. 2481. 2482. 2483. 2484. 2485. 2486. 2487. 2488. 2489. 2490. 2491. 2492. 2493. 2494. 2495. 2496. 2497. 2498. 2499. 2500. 2501. 2502. 2503. 2504. 2505. 2506. 2507. 2508. 2509. 2510. 2511. 2512. 2513. 2514. 2515. 2516. 2517. 2518. 2519. 2520. 2521. 2522. 2523. 2524. 2525. 2526. 2527. 2528. 2529. 2530. 2531. 2532. 2533. 2534. 2535. 2536. 2537. 2538. 2539. 2540. 2541. 2542. 2543. 2544. 2545. 2546. 2547. 2548. 2549. 2550. 2551. 2552. 2553. 2554. 2555. 2556. 2557. 2558. 2559. 2560. 2561. 2562. 2563. 2564. 2565. 2566. 2567. 2568. 2569. 2570. 2571. 2572.



Bedding Down

By ELON JESSUP

WORRIED about excessive vibration in your boat? Maybe you have been all over the motor and are still unable to find the cause. Don't always blame the engine. Trace further back. Possibly you will find the seat of the trouble in the engine beds. Weak or inaccurate mounting often leads to serious engine ailments. There are some engine beds you can actually see rattle.

Among common causes of vibration, misalignment of engine and propeller shaft, a bent or off-center coupling, a loose engine, and a sprung propeller shaft can with few exceptions be laid directly or indirectly to inadequate mounting. And this brings you to the foundation—the engine beds together with their supporting floors.

When you consider the punishment the beds and supports take, there is no wonder that they need to be right. They absorb the propeller thrust and the forward movement of the boat, they must stand the tilting and twisting of the hull, and with every roll the engine strains to jump free.

One lightly built 26' boat with a heavy engine vibrated intolerably for years. The owner tried about everything to cure it, including strips of rubber on the beds. Finally, in desperation, he ripped out the old beds and started fresh, installing considerably longer and stronger beds in their place. This did the trick.

During construction of the boat, before the planking goes on, is the best time to install the supporting floors for the engine beds, although the beds themselves should naturally wait until you are

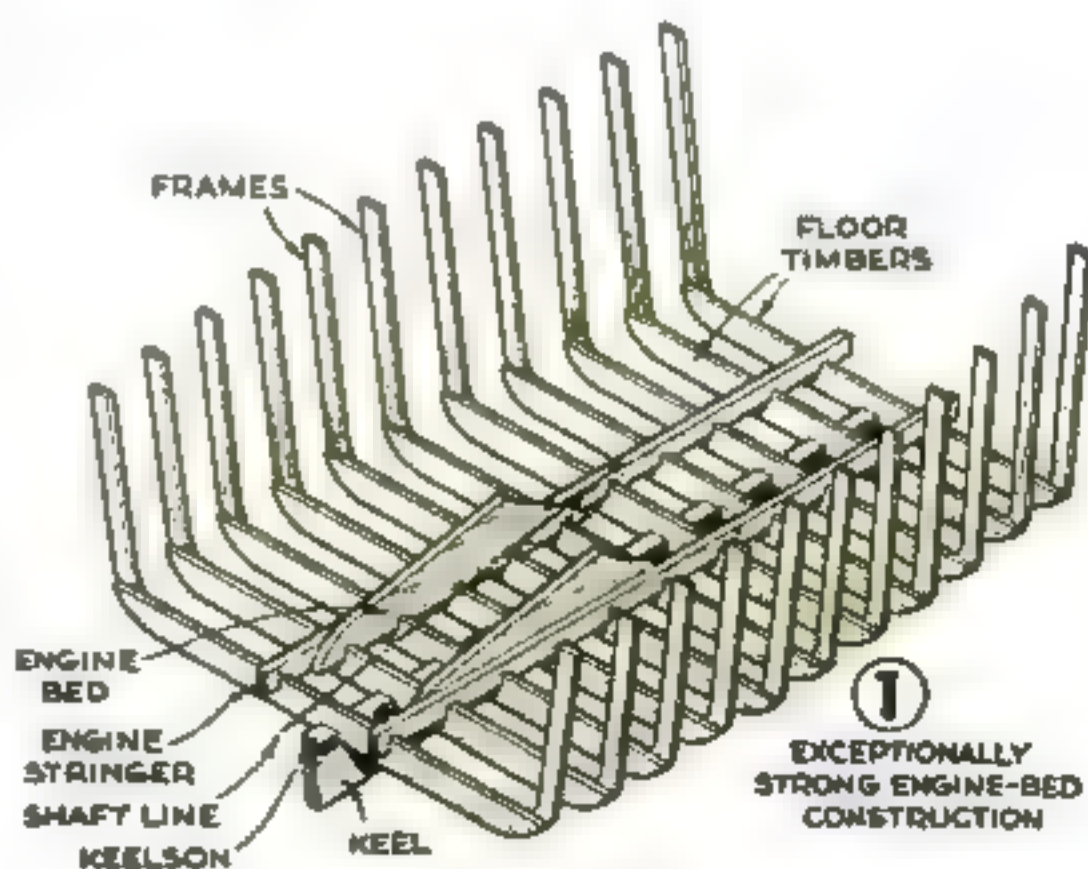
certain of the type of engine you will use. But this is not possible if you convert a sailboat to power or change engines.

Build your beds strong. Except for this, few definite rules can be laid down to cover construction. Methods vary to suit both engine and boat. As for the wood, white pine is often specified, but the holding bolts will not work loose as quickly in oak. Neither the beds nor their supporting floors should be much less than 2" thick. For a heavy engine they ought to be 3".

The base of the beds consists of three or more athwartship floors 1' to 2' apart, except for some small self-contained engines which may require only two. Don't build beds too short; it invites vibration by concentrating instead of distributing the strain.

Notches in the floors fit over the keelson, and each floor braces against the after edge of a frame to help hold against engine thrust. Bolt each floor to the hull with a drift rod right down through the keel. Countersink the hole in the keel, spread the rod over a heavy washer, and plug the hole when finished. The bolt hole should be about 1/16" smaller than the rod, and the rod should be hammered in. For additional fastenings, drive in strong nails or screws through the outside of the planking.

The two parallel beds straddle the floors lengthwise. Most of them slope, as shown in Fig. 1, and so does the engine, the slope corresponding to the shaft angle. In some cases, the beds are made horizontal for the engine to sit level, but this requires a special universal joint to compensate for the tilt in the shaft line.



Your Boat Engine

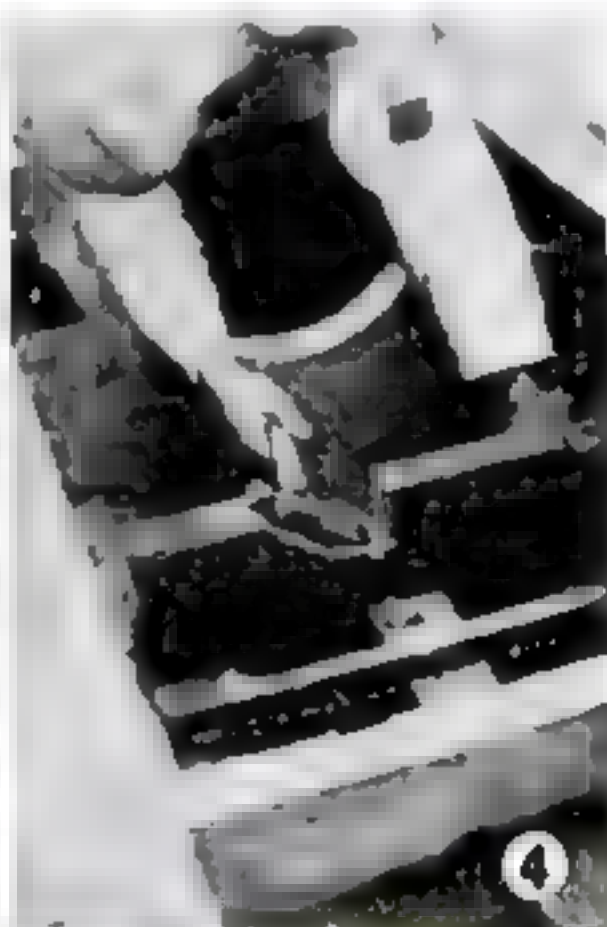
Notch the floors for a tight fit with the beds or, better still, halve the notches by notching both the floors and the beds. Drift rods are then hammered down through holes in the beds and floors.

The stringers shown in Fig. 1 give additional strength. This is particularly important in a flat-bottom boat where stringers will compensate for lack of floor depth. If they can run the full length of the boat without being in the way, so much the better. Notch them into the floors along with the beds, bolt the beds and stringers together, and sink drift rods as for the beds.

When you change engines some alteration is necessary unless they are the same

power, weight, and make. The photos illustrate some of these steps. Ascertain from the propeller shaft, if it is in place, or from a chalk line run through the shaft hole, where the center line of your engine will run. Whenever you have a choice, possibly with the use of a universal joint, keep the center line low. It makes the engine ride better and more securely.

In the boat shown, the new engine was longer and heavier than the old and had an underslung, rounded base while the old engine had a flat base. The old engine beds were supported by two floors, and an additional one had to be built in, as in Figs. 2 and 3 where one man is shown holding it



down and another fastening it through the planking. As shown in Figs. 4 and 5, the two old floors were partially cut away to take the underslung base; then (Figs. 6 and 7) they and the new one were notched for the beds. Figure 7 shows one bed in place and notches being cut for the second. Drift-rod holes are being drilled in Fig. 8, and a rod is being driven down in Fig. 9.

Figures 5 to 9 also show the chalk line indicating the center line of the engine. The propeller shaft was installed after the beds were built, and the engine was finally hoisted aboard, as in Fig. 10.

Before actually building the beds, you will, of course, either have measured your engine or have learned its shape and dimensions from the manufacturer. Figure 11 shows the measurements you will require for the average engine. You should also know the maximum operating angle of the shaft line.

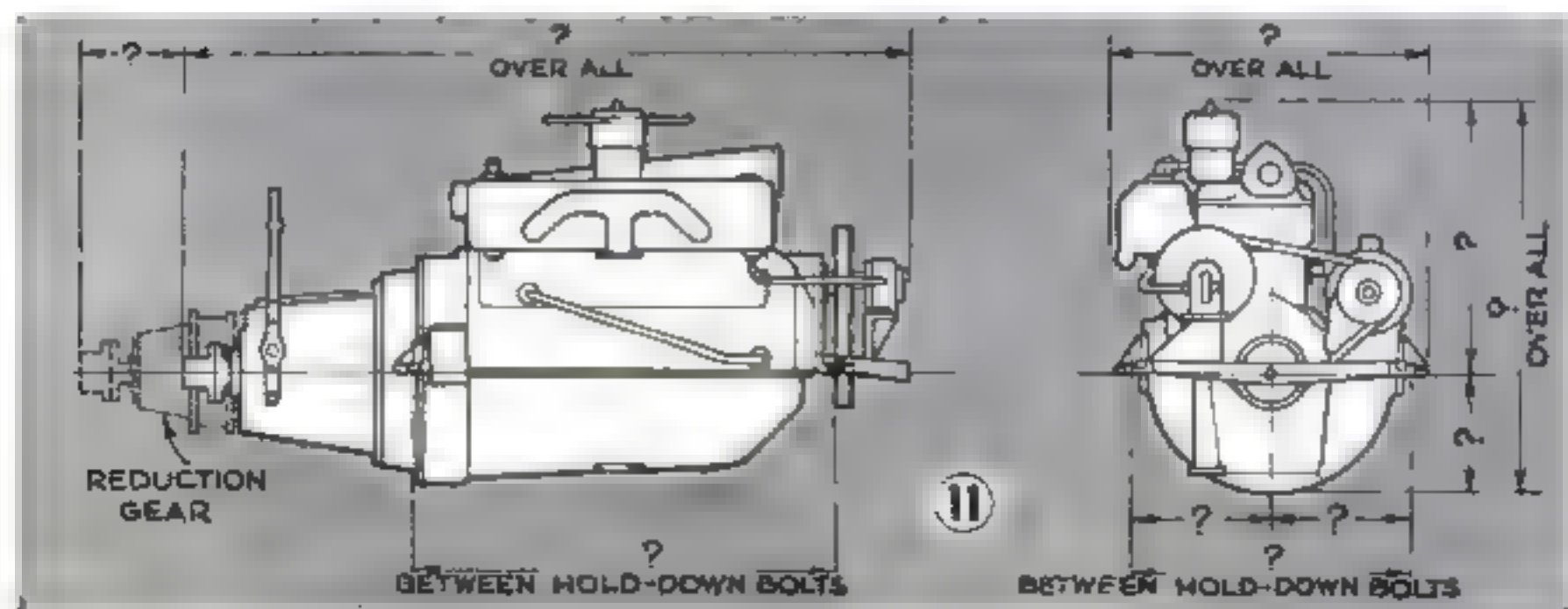
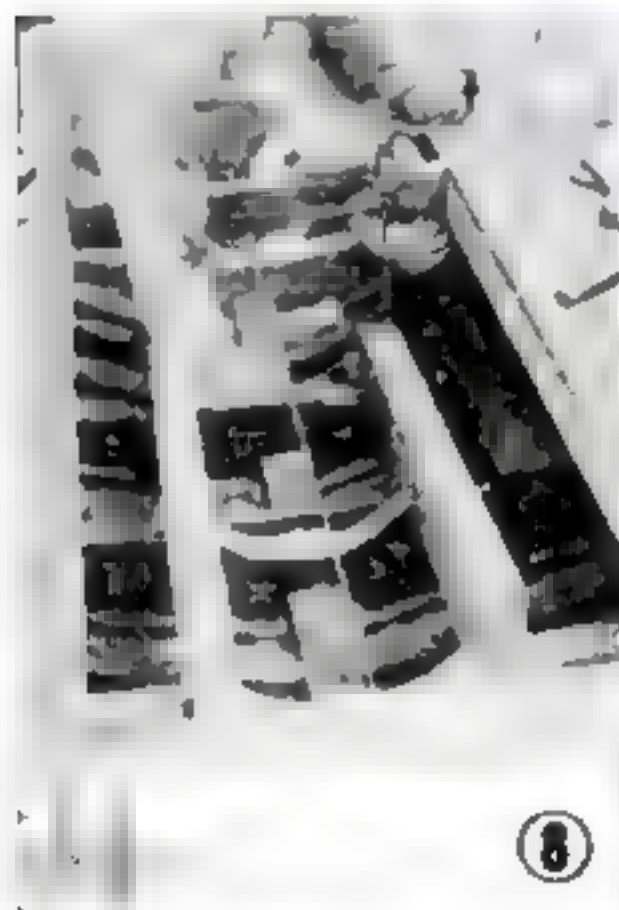
It is a good idea to drop the beds about $\frac{1}{4}$ " lower than the specifications call for in order to have working leeway. You can later raise the engine above its beds with thin metal shims if this is necessary.

Absolute accuracy is needed, however, after the engine has been lowered onto the beds. Before boring for the hold-down bolts,

line the engine up carefully with the propeller shaft. This alignment must be true both vertically and horizontally. Bring the two flanges of the coupling together, but leave out their connecting bolts, and give the shaft end one complete turn by hand, allowing the opposing flange on the engine side to remain still. Gaps as the shaft revolves show misalignment. Another test is to insert four slips of paper between the flanges at equal spacing around the coupling. If they can be pulled out with the same force while you press the flanges together by hand, you have correct alignment.

To correct faulty alignment, tap in wooden wedges about 6" long and tapered down from $\frac{1}{2}$ " thickness. Replace them with thin metal shims when you have the engine at the correct height. After that, drill for through bolts or lag screws.

Check the alignment again after the boat has shaken down in the water for two or three days; then check again a week or two later. These checks can be made by removing the bolts from the coupling flanges and proceeding as you did on first installing the engine. If there is any misalignment, loosen the hold-down bolts, tap in wedges, and fill in with metal shims. It is a good idea to repeat the tests occasionally.





The Finishing Touch



Phonograph records on display? This is just one of the many art finishes possible on metalwork. Abrasive spot-polishing on a drill press does it.

SKIN-DEEP BEAUTY MAY MAKE OR MAR YOUR METAL PROJECTS

By Walter E. Burton

THERE is one unerring way to distinguish the work of a real metal craftsman from that of a tinker. Take a look at the finish of any piece near at hand and you can tell immediately whether the maker was artisan or artless. More potentially excellent products of home workshops and even well-equipped factories have been rendered mediocre by poor finishing than by almost any other shortcoming. If you can afford the time and effort to make a thing, you'll probably find it satisfying to expend a little extra on that last finishing touch.

Probably the most common finish for metal is a smooth surface. This is usually

obtained with such tools and materials as files, steel wool, wire brushes, buffing wheels and compounds, and abrasive stones, papers, cloths, and powders.

Filing is often the first step in finishing—and it may be the only operation required. Polishing is the process of producing a smoother surface on metal than is possible by machining or filing, while buffing is the further step of working up a high sheen or gloss. Brushes are useful for the craftsman who makes bowls, platters, and the like of silver, copper, pewter, and other ornamental metals.

Then there are special finishes, such as the fancy surfaces on the ways of machine tools and the whirly designs that used to be standard embellishments inside the cases and on the works of fine watches. The former is a method of hand-scraping, the action of the tool producing a pleasing pattern that has come to be associated with good machine work. Spotting, frosting, en-

Draw-filing is often the first step in producing a smooth finish. Here an ordinary mill file is used to smooth a steel tube. The work is held tightly in a bench vise.

Further smoothing may be done, as shown at the far right, with an abrasive stone. Oil is the cutting lubricant. Use moderate pressure.

MAY, 1945





Buffing is a process of putting a high gloss on a metal surface. At the left, an aluminum part is being buffed on a cloth wheel charged with a buffing compound. Wheels of this kind can be prepared with glue sizing and abrasives.

Wire brushes both of the hand and power-driven type are useful in cleaning and polishing operations. In the photo below, a wheel-type brush is being mounted on a motor shaft. Soft-bristled brushes are also used with abrasives.



gine polishing, or whatever you want to call the whirls, can be done on your drill press

Bluing and similar finishes on gun barrels and other steel articles can be applied chemically or, in the case of small pieces, with heat. It preserves the well-groomed appearance even against wear and exposure. Peening is a hammered effect done with a ball-peen hammer. Punch-like chasing tools, normally stocked in almost endless design by craftsmen's supply houses, open a whole field of interesting surface designs on metals.

In selecting files, you have an almost unlimited range of sizes, shapes, and tooth forms. For rough filing, the teeth may be as coarse as 20 per inch; for finish filing, the number may run beyond 100. Both single and double-cut files are commonly used. Many craftsmen prefer to rub a new file a few times over a block of cast iron to remove burrs.

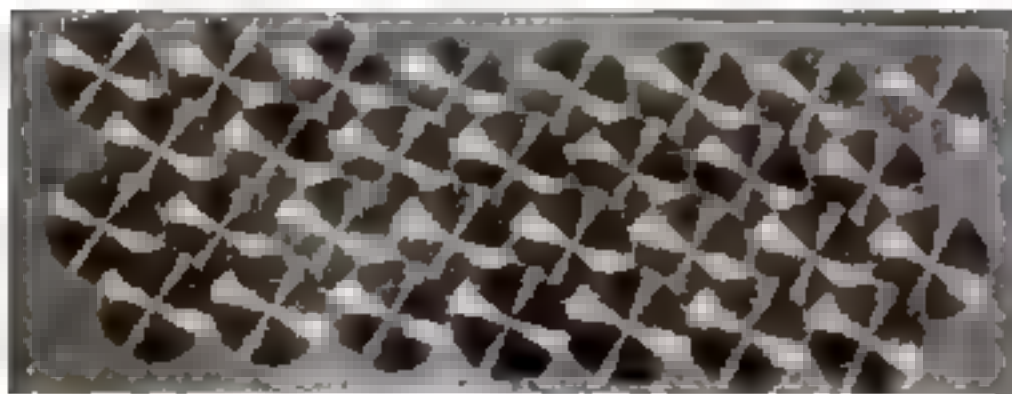
Draw-filing is one of the least difficult ways of producing true, even edges and faces or rounded surfaces. The work should be clamped firmly in a vise. Then a flat mill file is held in both hands as on page 181 and drawn back and forth in a direction at right angles to its own length.

Special lathe files have teeth cut at a steeper angle than those on hand files. Swiss files in various shapes are suitable for some lathe work, and there are special files for brass, lead, babbitt,

Applying a simulated engine-turned finish is done on the drill press with a short length of dowel having a felt washer on one end. The washer is charged with abrasive powder, or a disk of abrasive cloth is glued to it.



Compare this spotting with that shown on the preceding page. The spots overlap here only in rows. Intricate designs are possible with measured or freehand spacing.



and aluminum; but for a smooth finish, such as the surface of a shaft that will rotate in a bearing, a mill-cut file will do excellently. Hold it firmly at an angle of 90 deg. or slightly less to the axis of the work, and with the handle end slightly lower than the tip. Move it forward, not too fast and with not too heavy a pressure, in a direction at right angles to the work, which should revolve at a speed that is not too fast for the file to bite readily.

You should take care to keep grease and moisture from your hands off the parts being worked, or the file may slip without cutting. The file should also be cleaned frequently with a card, which is a stub-bristled brush, in order to prevent scoring from metal particles. It is well to remember that filing creates heat that expands the work. To prevent binding between the lathe centers, keep them free and well lubricated.

Steel wool is sometimes employed for producing a polished finish on soft metals like aluminum. Wire-bristled brushes, hand operated or power driven, are also often used for developing a finish on metal. But the most common polishing agents are the numerous abrasive grains and powders—such materials as aluminum oxide, silicon carbide, garnet, diamond, emery, tripoli, rouge, crocus, pumice, and rottenstone. These abrasives are usually combined with oil or some other carrier medium or are cemented on paper or cloth. The nature of the finish is dependent on the type and grade of abrasive and also on the type of carrier used.

Toolmarks, including those from machining in a lathe, may be removed with No. 60 emery cloth. The number of an abrasive grain refers to the number of threads or

wires per lineal inch in the finest screen through which the grains can be sifted. Anything finer than No. 220 is called a powder.

Abrasive cloth used for polishing a metal surface may be lubricated with sulphurized cutting oil or lard oil. After the surface has been worked with the No. 60 abrasive until no toolmarks are visible, a finer grain, say No. 90 or No. 100, will work out scratches left by the No. 60 grit, and a still finer size, about No. 120, will polish the piece further. The whole art of polishing and buffing is illustrated by these steps. One abrasive removes marks left by a coarser one.

Final polishing may be done with cloth or paper having an extremely fine abrasive coating, such as crocus cloth. Powdered abrasives mixed with oil or wax are also commonly used. The smoothness required will determine just where you stop. For a shop tool, polishing with No. 80 or No. 100 abrasive cloth may be sufficient; for such articles as a silver brooch, buffing with rouge is good. In buffing, as in polishing, there is a choice of grit sizes.

For machine polishing, a stiff cloth buffing wheel, composed of disks of muslin or similar material, may be prepared by sizing it with a coating of thin, hot hide glue on the periphery and then rolling it in powdered abrasive of about No. 150 grit. Thicker glue is next applied, and the wheel is finally rolled in grains of the size to be used. When the glue dries, the wheel may be operated at speeds up to 7,500 surface feet per minute.

You can also charge a hard or soft buffing wheel with a stick of buffing compound held against it as it revolves. Tripoli composition is a good charge for buffing copper, silver, gold, aluminum, brass, or platinum after a first buff with emery paste. Rouge paste or stick is a final buff for gold, brass,

Hand-scraped surfaces are a hallmark of fine work on the ways of machine tools. Here a cross-slide block of a lathe is being scraped in an irregular pattern after having been polished. The scraping both levels the surface and supplies the finish.

Steel parts that are subjected to great wear and to exposure are often blued to resist marring of the appearance. Small articles may be blued with heat, as in the electric furnace shown below. The color change takes place at a certain temperature.





Peening gives pieces an antique hammered effect. An ordinary hinge like the one shown above can be hammered to look as if it had been made by hand. Practice is required to get an even pattern.

Interesting textures may be worked up on plaques and other metal pieces with a nail set hammered on the surface, as at right, like a chasing tool. Special shapes can be ground on punch ends.



and silver. Crocus composition is used on many metals as a preliminary buff and is fast-cutting.

If you have a number of cloth wheels, you might start a job with one charged with emery paste or crocus, next use a wheel charged with rouge, and work up a final sheen with one not charged at all. The work should be cleaned thoroughly between wheels to keep coarser compounds from contaminating finer. It is a good idea to wear goggles or a mask to protect your eyes.

Soft-bristled hand brushes may be charged with abrasive grains and swabbed over such metals as silver, copper, and pewter for a distinctive polish. Power brushes may be used in a similar way, but the abrasive should be mixed with a carrier. Much work can be done with wheel-type power-driven wire brushes. Steel-wire hand brushes are useful for removing rust, cleaning surfaces in general, and producing a satin finish as well. Crimped steel brushes will work up the semidull finish resembling fine satin that is so attractive on silver, pewter, and aluminum, while for a satin finish on gold, brass, and copper, a crimped brass brush is satisfactory.

The war has spurred polishing activity in toolmaking. Dimple punches and dies for forming rivet holes in airplane skin must have polished surfaces free of toolmarks. A typical method is to machine the tool smooth in a lathe and perhaps touch it up

with a Swiss file. It is then transferred to a polishing lathe, where the toolmarks are removed with fine abrasive cloth, or the surface may be smoothed on a suitable grinder. Next, a very fine abrasive cloth works out the scratches, and the tool is finally polished with a pointed wooden stick dipped in a mixture of oil and some very fine abrasive powder such as FFF aluminum oxide.

Hand-scraping of the surfaces of machine tools produces pleasing patterns that are often purely decorative. One of the photos shows the treatment of a cross-slide block on a lathe. After the block was squared on a surface grinder, a pinch of No. 120 aluminum oxide grit was placed on each surface and a few drops of oil added. A steel block was used as a rubbing tool to work up a finely ground surface. The final scraped design was produced with a wide chisel having a slightly curved edge, the marks being scored in various directions.

Spotting may be done on a drill press with a 3" length of maple dowel on the end of which is glued a thin felt disk. The diameter of the dowel should, of course, fit the drill-press chuck. A disk of fine-grit abrasive cloth may be glued to the felt disk, or the felt may be charged with a mixture of some fine abrasive and oil. The drill press is run at moderate speed to put the spot designs on the previously polished surface. Many designs are possible. Two are shown in the photos, one with all spots

overlapping, and the other with overlapping rows. The centers may be measured and marked on the surface, or you may do the work freehand.

Chemical bluing of firearms and other steel articles that must withstand wear and exposure is actually an oxidation or rusting process. Bluing chemicals and kits can be purchased from dealers in firearm supplies. A quick way of bluing small steel articles is by heating in an electric furnace or with a torch or other nonluminous flame. Besides blue, you can produce such colors as bronze, straw, and purple. You merely heat the article slowly and uniformly until the desired color appears, and then remove it instantly and cool it in water or let it cool in air. When a furnace is used, a good bluing temperature is 660 deg. F.

Silver, copper, wrought iron, or gold is peened by hammering with a ball-peen

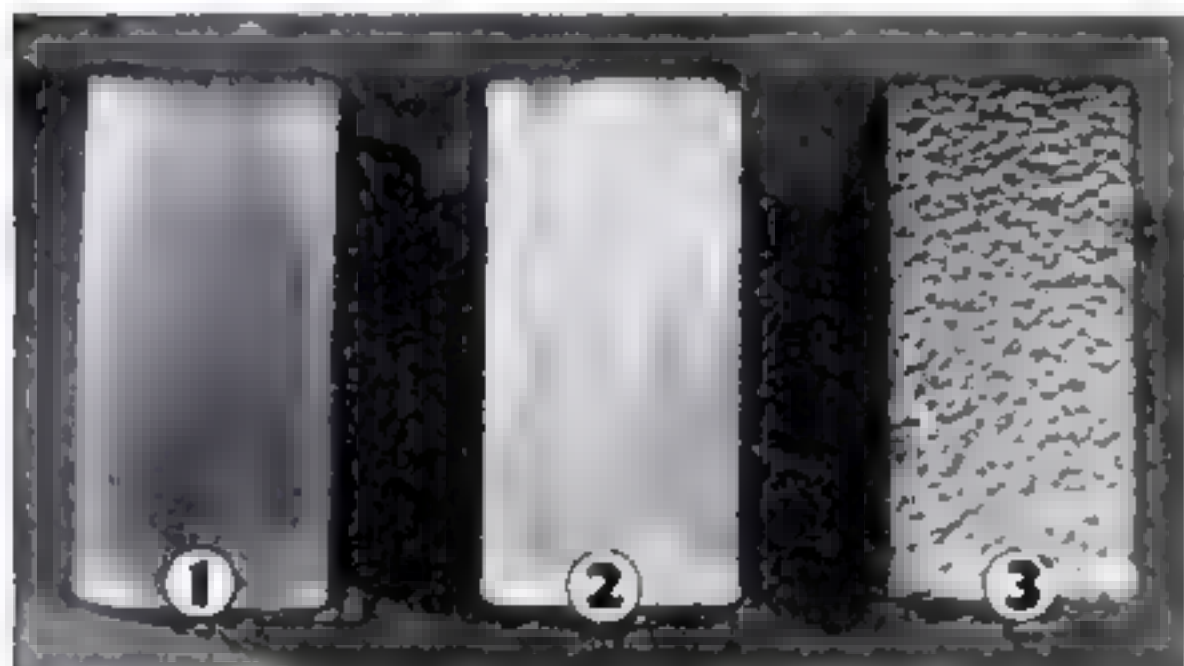
hammered like punches to form the markings. Much the same effect can be obtained with a nail set, one or more being used to produce an interesting texture.

Many craftsmen seem to be at their worst in finishing metal with lacquer and enamel. So many things can be done poorly, such as having the finish too thick, brushes dirty, and the room too cold or dusty. Transparent lacquers are used on silver, copper, and brass to prevent gradual darkening in the atmosphere. Ordinary brushing or linoleum lacquer will serve, although for maximum permanence a lacquer that can be hardened by baking is better. A spray gun makes the smoothest finish, and bake-on enamel—which comes in various colors—can be used in such a gun. The baking is done in an oven at the enamel maker's recommended temperature.

Some baking enamels produce attractive wrinkled surfaces that may be used on metals that aren't especially smooth, such as castings that have not been machined. Automobile lacquers are useful with spraying equipment. They should be rubbed to a luster with lacquer-rubbing compound. Synthetic enamels are applied with a spray gun and require no rubbing. Undercoaters, primers, and thinners should be used with lacquers and enamels.

There are dozens of other finishing materials, and the war is causing the development of still more. The chief prerequisite to a good enamel or lacquer job, however, is to have the surface of the work absolutely free of rust, grease, oil, and moisture.

Here are three surface effects produced on cast iron by use of different methods. (1) Buffed metal after polishing with abrasive cloth; (2) draw-filed; and (3) peened with a hammer.



hammer or one having a specially shaped head. Ordinary hinges can be peened to look like a handsome handmade or antique pair. After peening they are heated red-hot, and will be on the dark side when cool. Abrasive cloth highlights the peened design, and floor wax may be used to preserve the contrast produced.

This method can be followed for copper, silver, and other art metals. A silver brooch, for example, may be hammered, heated to darken the metal, and then high-lighted with abrasive cloth or a wire brush. Dark antique colorings may also be produced on silver by immersing a well-cleaned piece in a pint of near-boiling water containing 100 grains ammonium carbonate and 50 grains liver of sulphur. Clear lacquer will preserve the contrast after high-lighting.

Chasing tools, which come in various designs, are placed on the metal surface and

These additional finishes illustrate further the varied possibilities of treatment of cast iron. (4) Random hand-scraped design made on a polished surface and (5) texture produced with a nail set.

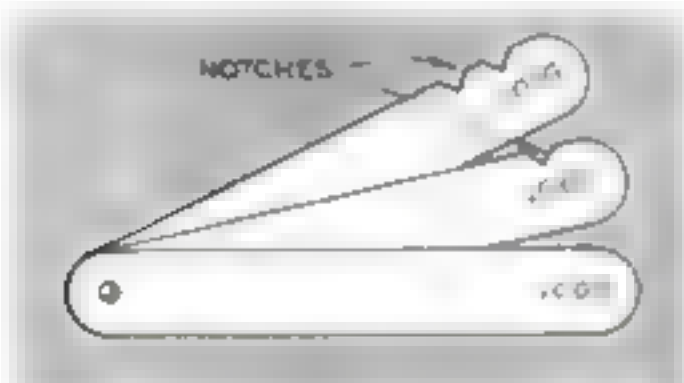
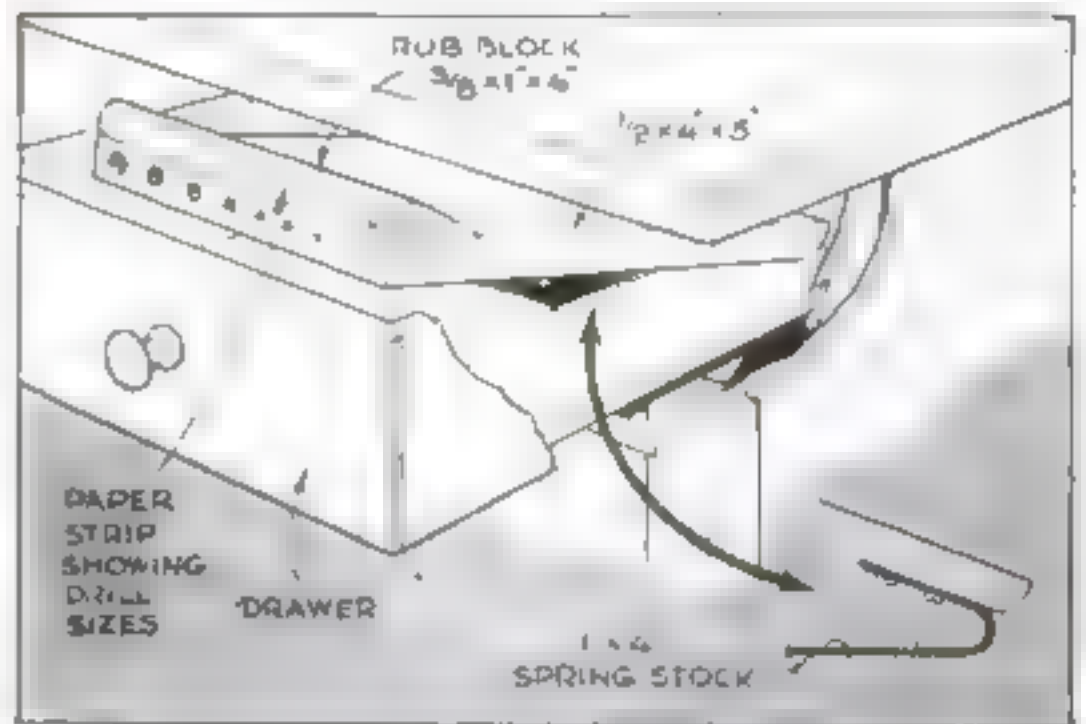


NEW SHOP IDEAS



EFFICIENT COOLING of work and tool is possible with this flexible nozzle, which was taken from the spout of an oil can. Designed for use on a lathe or other machine tool, it will not break under repeated adjustment, as will the lengths of semirigid copper tubing customarily used. It can easily be bent to direct the stream and yet is stiff enough to stay in place despite vibrations. The spout shown above is silver-brazed to a copper tube leading to the reservoir.—W. E. B.

YOUR DRILLS STAND UP like soldiers to be counted when kept in a trick device like that shown below. One big drawback of tool drawers can be overcome by means of such a rising drill holder. Lying flat inside a drawer as shallow as 1" in depth, it rises to a 45-deg. angle as the drawer is opened, making it possible for you to select the proper size of drill from its plainly visible markings. A 1" by 4" strip of springy metal gives the jack-in-the-box effect that puts the most commonly used drills within easy sight and reach. Since a snug fit will keep the drills from falling out, make each hole in the holder with the drill that will be stored in it.—C. T.



LIKE PEAS IN A POD, blades of thickness gauges are sometimes just as hard to distinguish in cramped or dark places. Filled notches, such as those shown at left, eliminate fumbling and remain clear long after the original stampings have worn off. To avoid burrs that would change thickness, clamp each blade between two sheets of heavier metal before you file the index notches.—RONALD EYRICH.

SCREW THREADS can be checked with sufficient accuracy and uniformity for most practical uses by means of plano wire, but the problem of keeping the musical strands assorted sometimes strikes a discordant note. Mechanics find some sort of kit is necessary for carrying the most frequently used sizes. The one shown at the right answers the purpose better than most. Made of suede or other soft leather, the smooth outer surface readily takes India-ink markings, while the rough inner side can absorb a small quantity of oil to prevent rusting of the wires. Cutting these wires to different lengths will enable you to sort and distinguish those of similar size quickly. Cards containing the formulas and tables used with thread pitch diameters are inserted in the large facing pocket, which will keep them ready at hand. The cards will also serve to stiffen the kit.



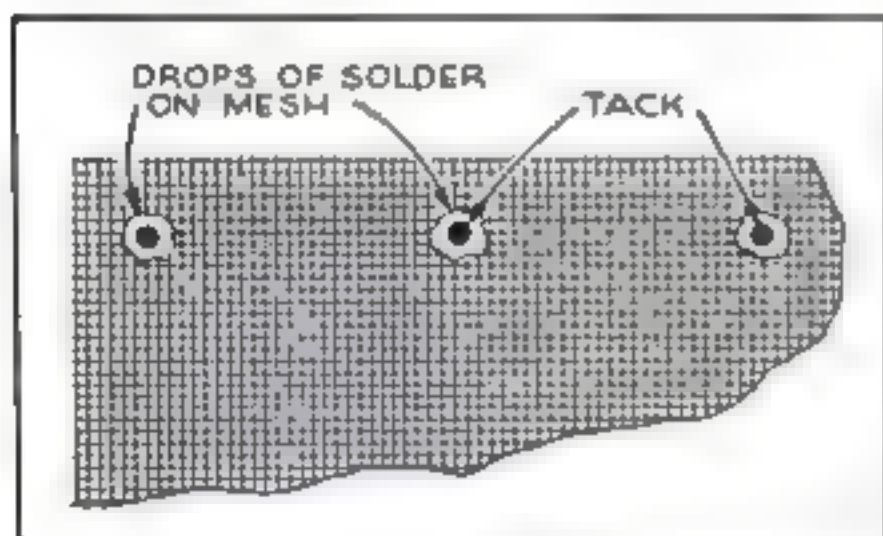
Cellar-Wall Greenhouse Yields Flowers All Year

IN THE spring a gardener's fancy turns to thoughts of growing flowers. To turn these fancies into facts as early as possible, the usual procedure is to purchase partially grown seedlings, but you can add to your horticultural enjoyment by building an inexpensive greenhouse similar to the one shown at the right. Besides the pleasure of raising your own seedlings, another advantage to having a greenhouse is the possibility of raising hardy blooms throughout the year.

Built against a cellar wall and window, the greenhouse has a foundation that must be carefully dug to guard against a cave-in. A cinder and gravel floor will protect the exposed house foundation from seepage. Concrete blocks are probably the most serviceable foundation material, but brick, cement, or cinder blocks will do nearly as well and at smaller cost. Fasten the sill to the foundation with anchor bolts and position the sash bars upon it; then secure the glass panes to the sash bars, preferably from inside, by means of glazier's points and plastic cement



—this combination stands up well under changes in temperature. A sash door, hinged to the roof, is a convenient ventilator. It should overlap enough to drain off rainfall whether open or closed.—W. F.

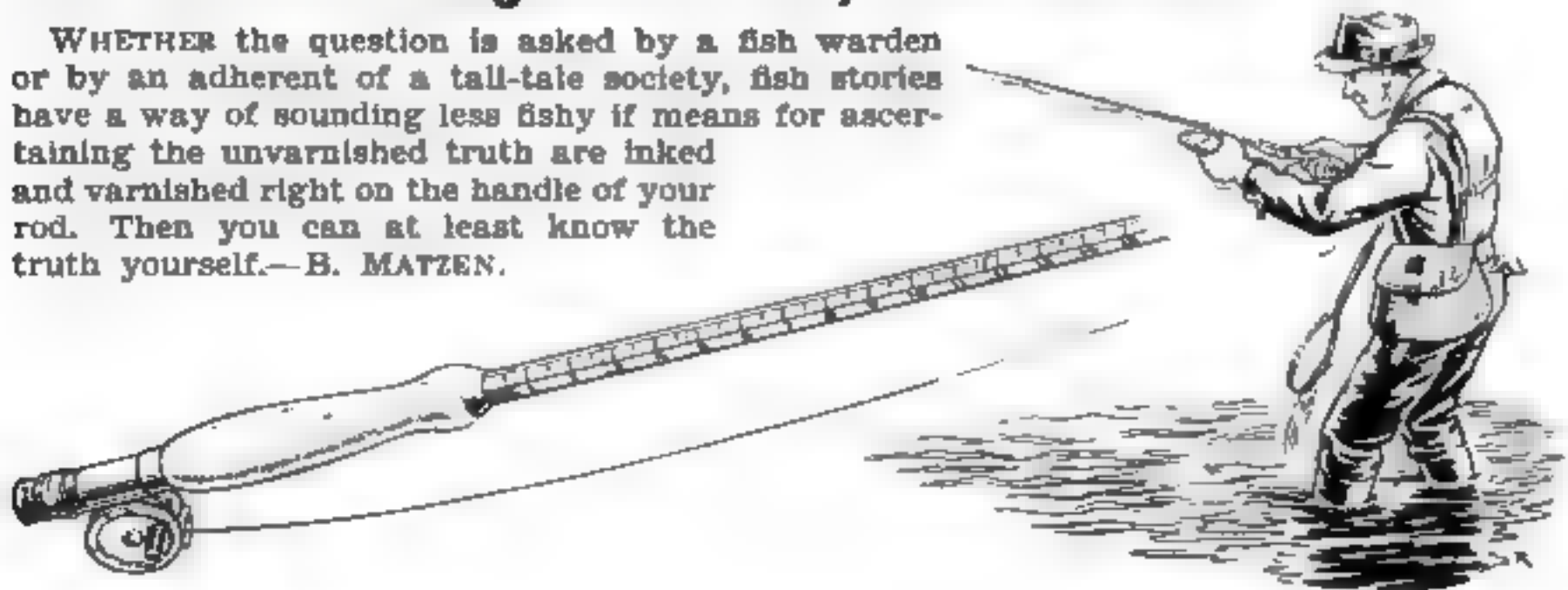


Solder Reinforcements Prevent Tearing of Screen by Tacks

ONCE started, small rents in copper or galvanized screening have a way of spreading out—especially when the mesh is stretched tightly over a frame. The parts of a screen that are most likely to start to tear are those that lie just under the tacks. To prevent this, melt a drop of solder at each point to be tacked.—JOHN KRILL.

Now Just How Long Did You Say That Fish Was?

WHETHER the question is asked by a fish warden or by an adherent of a tall-tale society, fish stories have a way of sounding less fishy if means for ascertaining the unvarnished truth are inked and varnished right on the handle of your rod. Then you can at least know the truth yourself.—B. MATZEN.



High-Tension



Freedom from mosquitoes and other insect pests can be yours in your garden on summer evenings with a high-voltage insect killer like the one shown here. Hung high on a pole or in a tree, it will also light supports served on a terrace or cooked at an outdoor fireplace.

PERHAPS insect pests make life unbearable on your terrace or in your garden on warm summer evenings. Here is an insect killer, deadly in every sense of the word, that will both lure them and execute them. It is a high-tension device, and an insect need only pass between its electrodes—not touch them—to cause a

spark to jump across for the coup de grâce. For the protection of both persons and animals, be sure to hang the killer on a tall pole or in a tree well out of reach.

To obtain sufficient voltage to arc over on luckless insects, you will need a high-voltage transformer. About the best for the purpose is a 10-millamp. neon-sign transformer that steps up 110 volts to 6,000 volts. Neon-sign repair shops often carry serviceable used transformers since these items are frequently turned in for new ones. Get an open-type transformer, if possible, in preference to the kind that is



Insect Killer

By
JACK MELLINGER

sealed in the casing with a compound.

The top and bottom of the insect killer are varnished wood disks joined by three 10½" dowels. They serve as insulated plates to which the electrodes are attached. Make them of soft wood that is thoroughly dry, or dry them yourself by leaving them for several days in a mildly heated place before applying the varnish. If they contain any moisture there may be sparking across the moist places. For this same reason, the device should not be left hanging in a rain.

Cut the electrodes from scrap copper, zinc, aluminum, or any metal that will not rust, making them long enough to be bent over at one end, as shown in the drawing. Space the electrodes not quite all the way around the disks about $7/16$ " apart, with the bent ends alternating at top and bottom, and brad them to the edges. It is important that the spacing be equal, for the current will jump any gap that is appreciably narrower than the others. The open section between the first and last electrodes is left for a cleanup door.

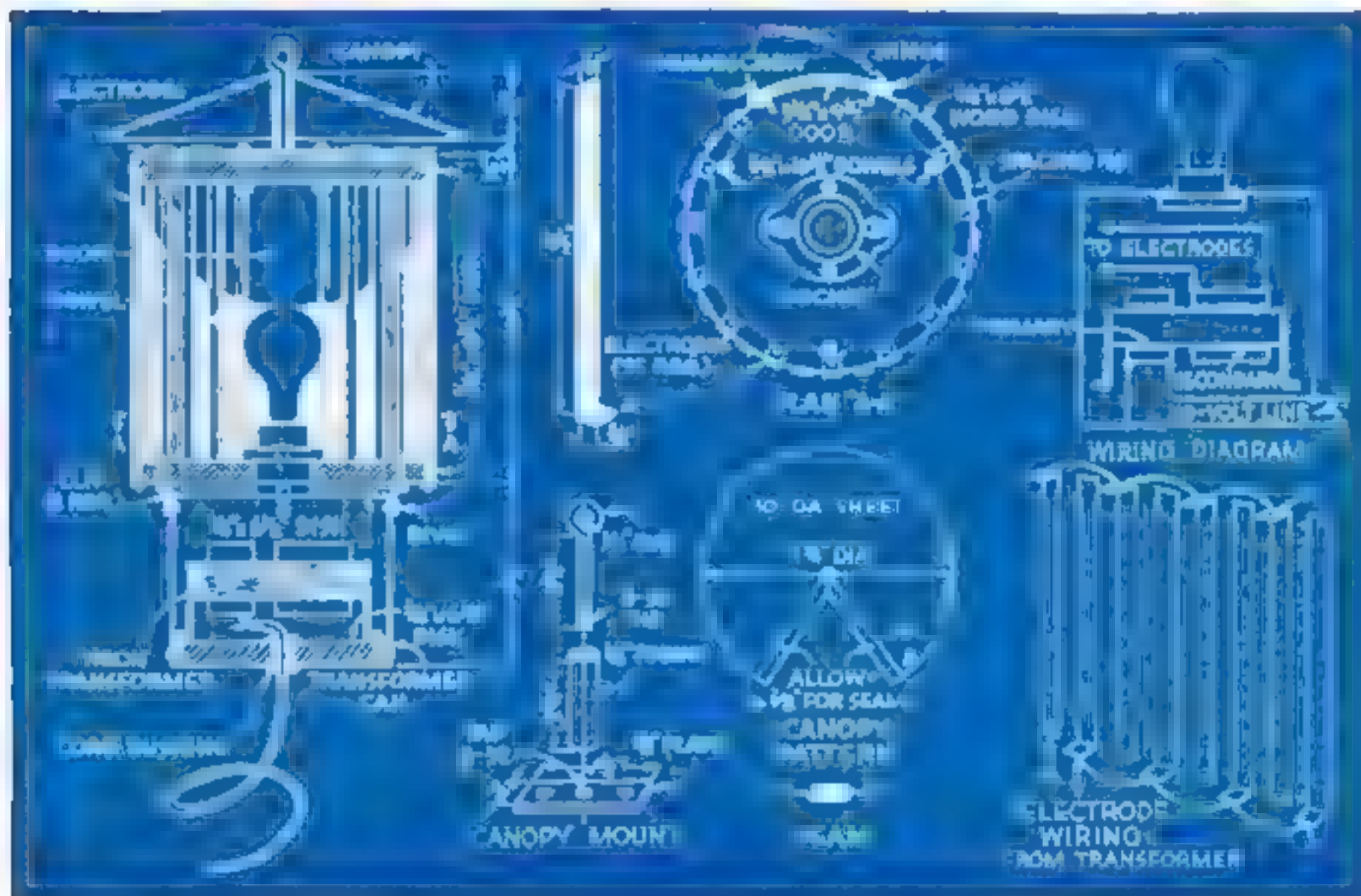
Wiring of the electrodes is tricky but not difficult. Every other electrode is connected at the top with 22-gauge bare copper wire wound around a brad driven into the bent.

over section and looped to prevent sparking at the in-between electrodes. Then the alternate electrodes are similarly connected beneath the bottom disk.

The door is cut from sheet metal and supported between two posts about the same width as the electrodes but long enough to be bent over at both ends for additional strength. Small hinges are soldered to the door and one post, while a small screw is soldered to the other post and a hole is cut in the door to take it. A thumb-screw then serves to latch the door.

Install a standard porcelain socket on the bottom disk and suspend the transformer under it inside the transformer housing. This housing should not fit so snugly that heat cannot escape. If your transformer was purchased unhoused, a satisfactory housing can be made from a large tin can.

A long piece of rubber-covered cord plugs the device into a house outlet. It is connected to the transformer primary and the lamp socket, as shown in the diagram, while the leads of the transformer secondary connect with the electrodes. Protect the top of the device with a sheet-metal canopy, paint the canopy and transformer housing, and be ready to enjoy life in the open.



Fighting Welders Work Battle-Line Miracles

By TOM MAHONEY

A HAIL of bullets from Japanese snipers stopped American forces advancing through the dense jungle on New Georgia—but not for long. Ever-resourceful Army engineers immediately cut steel plates from Navy pontoons used in landing on the island and welded them as armor plate to bulldozers. With these as "points," infantry columns pushed ahead to capture Munda air field. And so well did the improvised armor protect the soldier drivers that welded steel cabs are now standard equipment for bulldozers in the fighting areas.

This is just one example of how the Aladdin-like power of welding to fuse pieces of metal, swiftly and strongly, is helping fight the war on the actual battle front as

well as in factories and shipyards. Thousands of service men have been taught welding. Army and Navy construction battalions boast welding outfits. Every Navy ship as big as a destroyer has welding equipment for the repair of battle damage. There are even welding machines in some airplanes and jeeps.

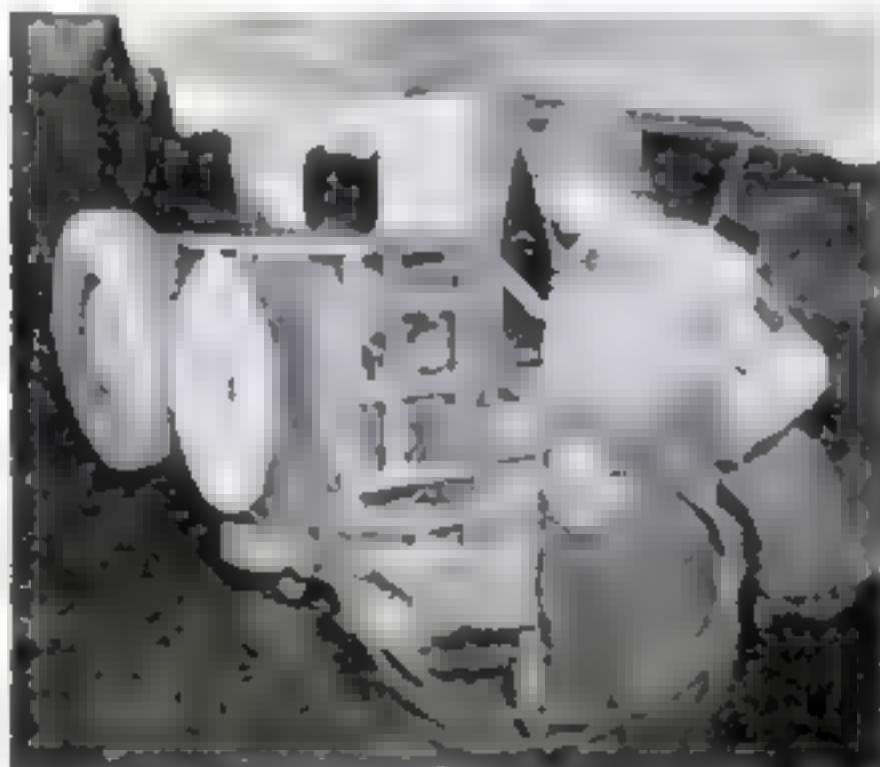
The three major techniques—gas, electric-arc, and resistance welding—are all used overseas by Lieut. Gen. Brehon Somervell's Army Service Forces. The spot and seam-welding forms of resistance welding (so-called because resistance to electricity supplies the plasticizing heat) have saved tremendous quantities of ship cargo space. Twenty droppable airplane gasoline tanks, for example, are shipped in halves in the

Repairs Made on Battlefields with Rugged Welder Jeeps

THAT ever-versatile jeep has been pressed into one more service. Now the the U. S. Army's car of all purposes has been equipped with a General Electric arc welder so that repairs to damaged tanks and other front-line war equipment can be made under fire right on the spot. Thus tanks, guns, and other weapons are often put back into the fight within minutes after receiving a hit.

The jeep with welding equipment replaces heavier units that have required the use of a 5-ton truck and a 1½-ton trailer. Being extremely light and maneuverable, welder jeeps can negotiate rough and even muddy ground where larger and heavier trucks would find the going much too difficult.

The welding unit is installed in the jeep in place of the right front seat and still leaves room for the crew of three men. It includes a generator capable of providing 40 to 250-amp. current, sufficient for handling electrodes up to ½" in diameter. Power is supplied by the jeep engine itself, which is engaged with the generator belt by a hand-operated clutch. A governor keeps the engine speed constant during welding. The highly mobile welding shop is thus ready for work the moment the jeep is brought to a halt at the scene.



Above, gas welding equipment in a special rack on a jeep. Below, the versatile electric welder jeep.





Drawing courtesy General Electric Co.

Repair crews working under fire must be ready to drop their welding electrodes and grab their Garandas.

space required for one completed container. At advance bases, the halves are seam-welded together. Metal for making the Army's famous 5-gal. "biltz" cans goes abroad in sheets, and these cans are likewise seam-welded at plants in Hawaii, India, Egypt, Iran, England, and elsewhere. These expendable containers are used by the thousands for gasoline, oil, water, and food.

But it is in the field of gas and electric-arc welding and gas cutting that Uncle Sam's fighting welders perform their boldest feats and have their most spectacular adventures. The gas torch, which sometimes burns at 6,300 deg. F., is hot enough to cut through metals even under water. Divers use a torch to which has been added a metal "skirt" under which compressed air is released to form a bubble that protects the burning oxygen and acetylene from the water. An employee of the Navy's Bureau of Ships has devised for divers a new pickaback gas out-

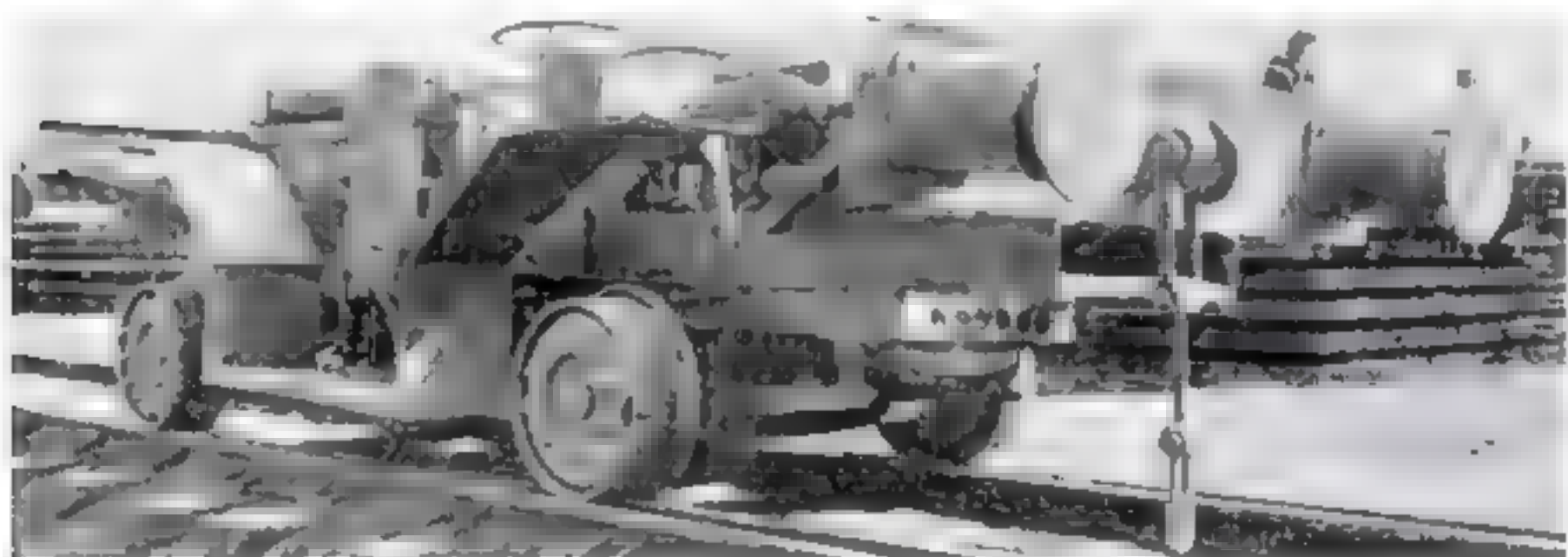
fit weighing only 57 lb. New electric-arc electrodes with an air passage inside are also used to cut up wrecks under water.

While fires were still burning at Pearl Harbor, gas torches cut through twisted steel hulls to save several men trapped in sunken ships. For the subsequent miraculous salvage job, seven hundred additional welders and all cutting and welding equipment available on the West Coast were rushed to the scene by ship and plane. Many other harbors have since been cleared in the same manner, and in Europe gas torches have even been used to cut up metal pill-boxes in the Siegfried Line. To meet aviation and medical as well as welding and cutting-gas needs, the Army engineers operate newly designed semiportable oxygen and acetylene generating plants in trailers behind the front. These make it unnecessary to ship heavy cylinders long distances.

Welding has had a large role in the



At Milne Bay, New Guinea, Army engineers weld together sections of a landing craft shipped knocked down to conserve space. Such craft as this are used to invade Jap-held islands. The strange vehicle shown below was welded together from locomotive and truck parts and served as a switch engine in North Africa.



advance across the Pacific. A Special Amphibian Engineer Brigade established landing-craft assembly plants on New Guinea. At these, steel-plate sections were arc-welded into invasion fleets that have since taken island after island. Four welders received Bronze Stars for heroic repair work on Kwajalein in 1944. Said the citation for Technician Michael Nicholson: "As chief welder in an engineer aviation battalion during the construction of the air field, Technician Nicholson kept engineer machinery and vehicles in operation 24 hours a day, although spare parts were seldom available. Working night and day, he created replacements from salvaged Japanese materials to repair and rebuild broken and worn assemblies."

Army engineers also displayed their ingenuity on New Caledonia early in the war. To enlarge the commercial oxygen-generat-

ing plant on the island, they cut steel from abandoned ships, discarded ore cars, and salvage vehicles. A compressor was adapted from one formerly used in making rum.

For transportation by air in the China-Burma-India theater, truck bodies and similar large items have been cut in two with gas torches and then welded together after being flown over "the Hump" or to one of the air fields along the Ledo-Burma Road. Heavy construction equipment was moved this way from Assam for enlargement of the airport at Myitkyina. At this same place, Major Ira D. Keirn, from the Pennsylvania Railroad shops at Altoona, and Capt. Cecil R. Kirkwood, of Indianapolis, formerly boiler supervisor of the Ohio Division of the New York Central, directed welders in a remarkable repair job on the shattered Burma railroad. They worked minor miracles with broken rolling stock,



Army ordnance men, above, weld the broken axle of a truck. Patrols with portable equipment roved the embarkation roads in England for such emergencies.

Below, sections of the pipe-line system laid by Army engineers to carry water and gasoline across France are welded together with portable outfits.



track, and bridges. On one occasion they used arc welding to plug 699 bullet holes in a vital water tank.

A large part of the repair work on bulldozers, trucks, and shovels used to push the Ledo Road through the jungle was done with welding by a unit of Heavy Shop Engineers recruited from shopmen of the Caterpillar Tractor Company. They were led by Capt. Jean Walker and First Lieut. Edwin J. Andell and called their rain-soaked camp "Little Peoria" in honor of their home city in Illinois. Though replacement parts were usually 15,000 miles away, this outfit kept road scrapers, pile drivers, tractors, and power shovels in service.

Gasoline and water pipe lines, kept in repair by welding and largely fabricated by welding, helped United Nations armies advance in Burma, Africa, Italy, and France. These are usually 4" or 8" in diameter and



In the Solomons armor plate welded over bulldozer cabs protected the drivers as repairs and jungle clearing kept pace with the advance of the troops.

This remarkable photo by T/5 George W. Herold, of the Army Signal Corps, shows a fighting engineer cutting away the door of a Siegfried Line pillbox.



are operated by Engineer Petroleum Distribution Units. The battlefield welding of damaged tanks has become routine. For use where larger vehicles cannot go, some jeeps now have a small engine-driven welding outfit mounted in the seat alongside the driver. In Italy, members of the 36th Engineer Combat Regiment welded railroad wheels to some 2½-ton cargo trucks and used them as locomotives to pull the final supply trains along a captured stretch of railroad between Salerno and Naples. In Belgium, 60 bridges and two sets of locks wrecked along the Albert Canal were cut up and rebuilt by welding.

President Roosevelt has been the most famous beneficiary of Army welding. On short notice, ordnance men at Cairo with a Lincoln welder whipped together steel plates to convert an ordinary automobile into a bulletproof armored car for his use.



Can Dry Cells Be Recharged?

ONE OF life's less joyous moments comes when you badly need your flashlight, and find that its light is as feeble as a sick glowworm. Worth remembering, particularly in times when new cells aren't easy to find, is the fact that weak cells can often be given a longer lease on life by charging. Don't expect this to work on dead cells, though; those with bulging or pitted cases are past hope.

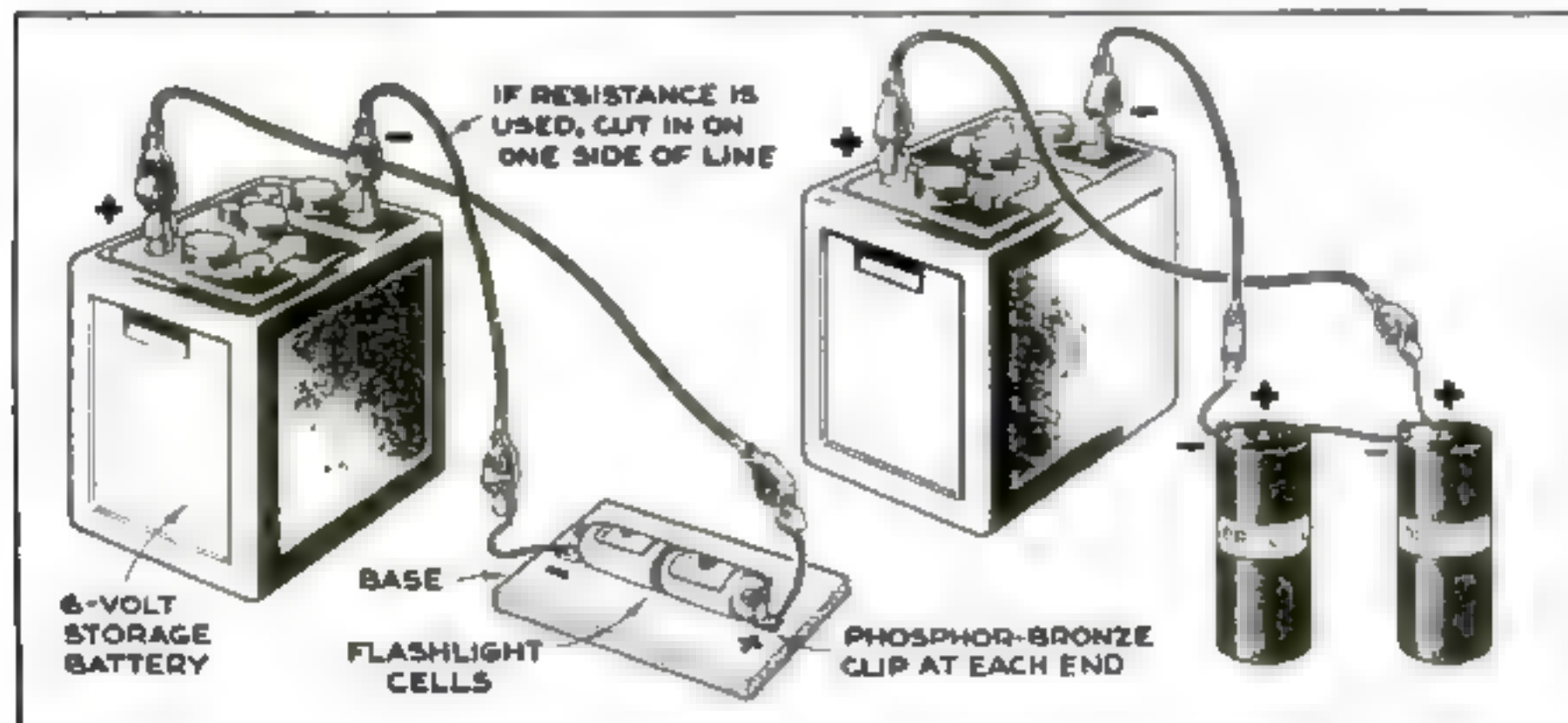
A setup for recharging flashlight cells is shown at the lower left. It consists of a wooden base and two spring contacts fashioned from brass or phosphor bronze. Two cells are placed together, just as they go into a flashlight case, and snapped in place between the two clips. One clip will then touch the bottom, or negative side, of one of the cells, and the other the center button, or positive side, of the other cell.

Wire the cells to a 6-volt storage battery, as shown. When they become warm because of the passage of current through them, which will take from two to five minutes, break the connection and allow them to cool. Repeat this procedure two or three

times, never letting the cells get hot. Although they may not last as long in service as new cells would, they will serve when new ones aren't available.

Any source of direct current can be used in place of the storage battery. The applied voltage must be greater than, but preferably not more than twice as much as, that of the cells to be charged. Since each cell has a $1\frac{1}{2}$ -volt potential, the charging source for two should be more than three volts, but not more than six volts. It is advisable to use less than twice the total voltage of the cells. If necessary, a resistance can be added to the hookup to limit the current flow, or three cells can be charged instead of two.

Larger dry cells can also be recharged by this method, as shown at the lower right. The charging time required is greater than that needed for flashlight cells—it will range from 20 to 30 minutes. Small B batteries, used in portable radios and hearing aids, can be boosted with a radio power pack. Insert a suitable resistance (5,000 to 10,000 ohms) in the hookup to prevent excessive current flow.—HAROLD P. STRAND.

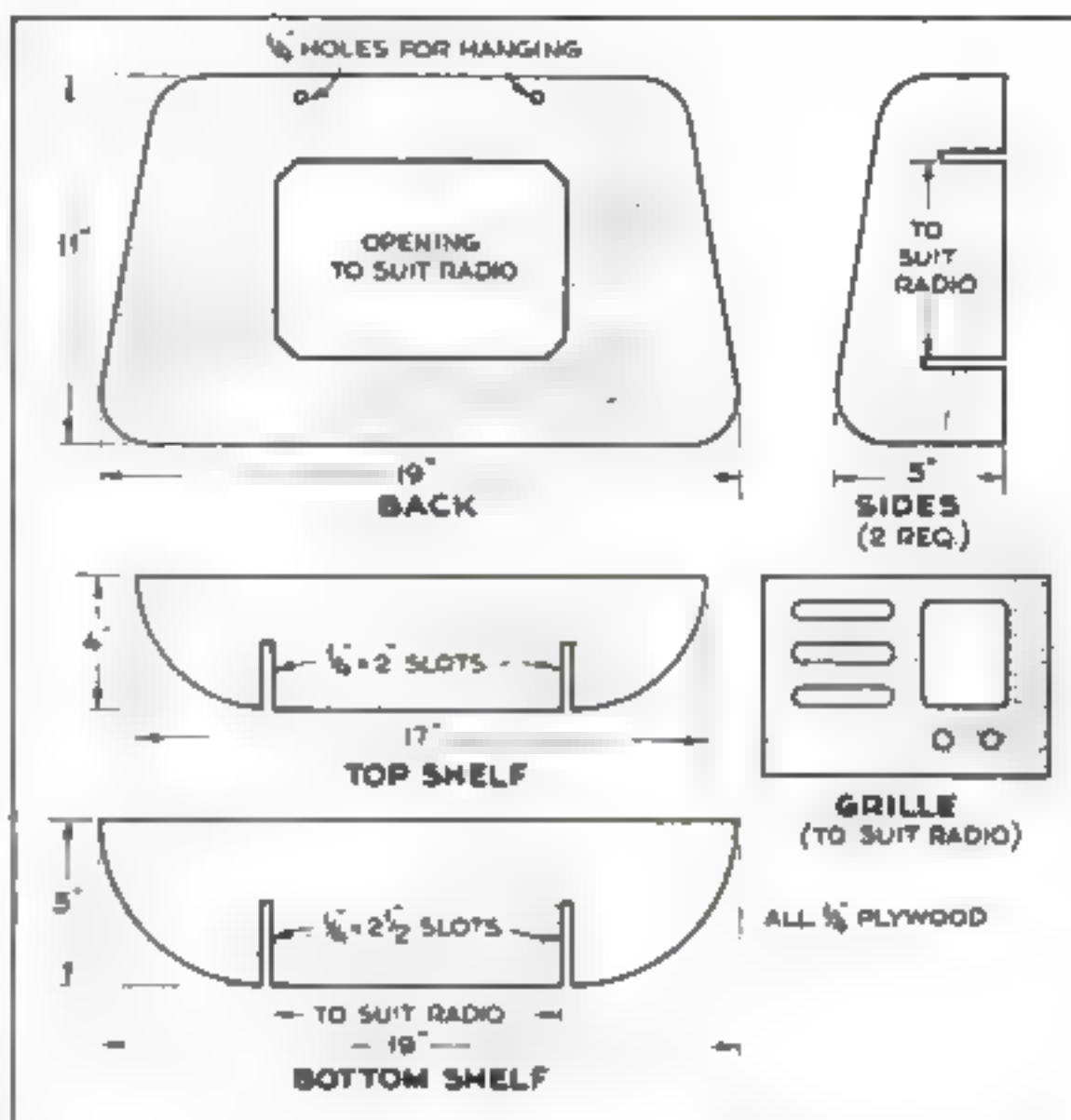




Cabinet for Small Set Combined with Shelf

TO KEEP the kitchen radio out of harm's way, a combination cabinet and hanging shelf like this will not only prove its worth but will hold the electric clock, flowers, and a few knickknacks. It is made of six plywood panels sawed as indicated in the drawing.

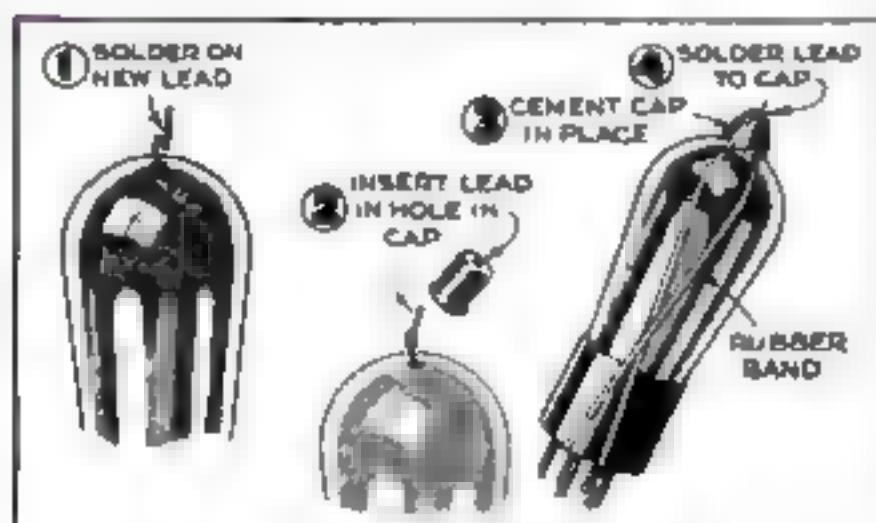
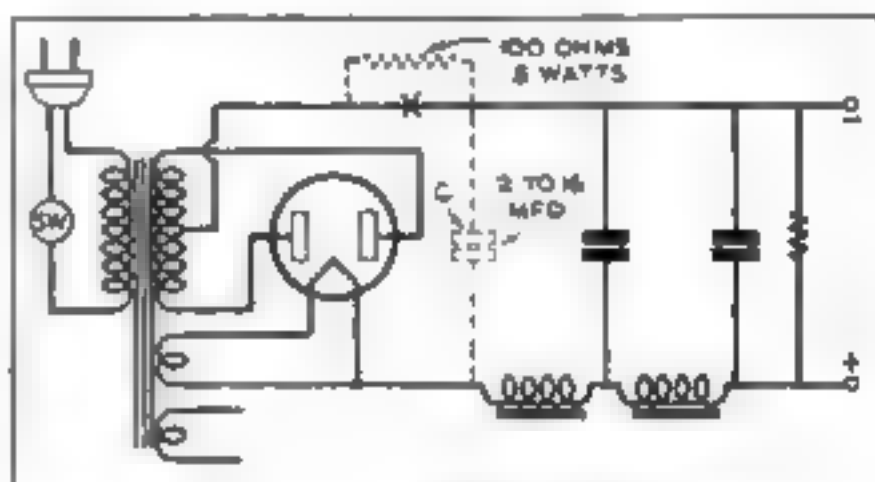
Top, bottom, and sides are slotted, as shown, for interlocking, and the back is screwed and glued to the assembly, although glue may not be necessary if the set



to be housed is light. Cut the grille to suit the radio and fasten it with brads.

Only outside dimensions are given since the others will, of course, have to accommodate the radio used.—E. E. YOUNGKIN.

PEPPED-UP OUTPUT can often be obtained from a B-voltage power supply of the choke-input type with the condenser shown dotted (C) at right. This 2 to 16-mfd. condenser across the rectifier-tube output drains heavier current through the tube during conducting periods. If the transformer secondary does not have a few hundred ohms D.C. resistance, place a 1 to 5-watt, 100-ohm resistor in series with the center tap of the high-voltage winding to avoid any possible overloading.—G. R. SONBERGH.



BROKEN-OFF GRID CAPS can be replaced on glass tubes without impairment of service by the four steps illustrated at left. First, scrape clean the short wire lead protruding from the top of the tube and solder another short wire to it. Then insert the wire through a hole drilled in the cap. Next, cement the cap on, holding it until the cement dries with rubber bands slipped over the cap and through the prongs. And finally, solder the end of the wire lead to the grid cap. Solder quickly to keep from weakening the cement.—HAROLD C. LESLIE.

radio ideas

PORTABLE PLAYBACK RECORDERS developed by General Electric for the armed forces are available now for commercial use. They are magnetic wire recording devices operating on 115 volts A.C. and are ready for playing back immediately after a recording has been made and the wire rewound. Each recorder is equipped with a 12,000' spool of wire which may be demagnetized for re-use or saved for a permanent record. Broken wires can be spliced for permanent repairs.

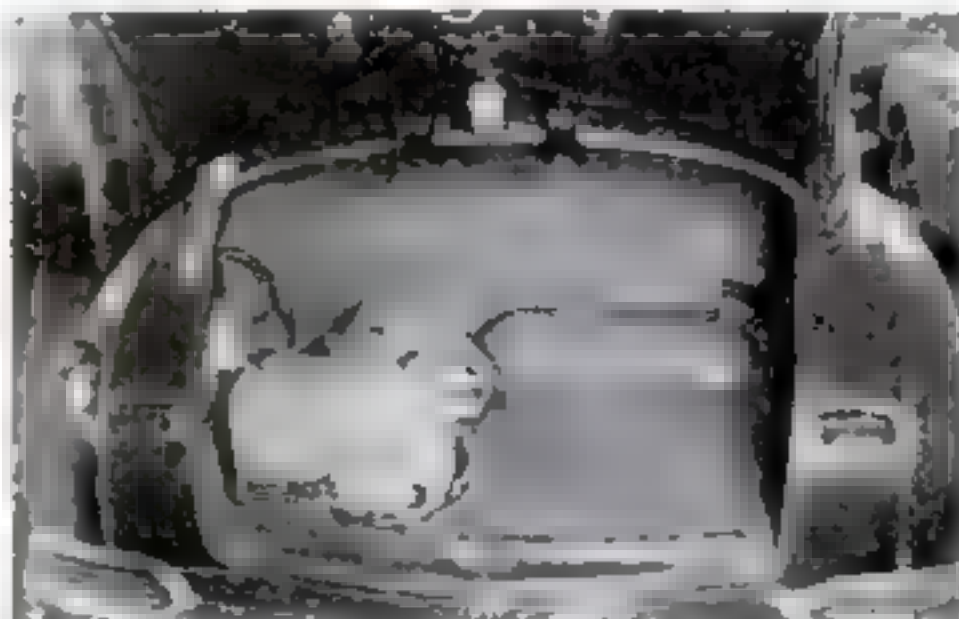


POSTWAR TELEVISION will embody eye appeal in its studios as well as on its programs. The station model shown above was designed by the Austin Company, engineers and builders. It has one large and two small studios. Sliding stages in the large one permit rapid change of scenes. The small studios are served by a common control room adjoining that for the large. This centralization is held to provide maximum flexibility of operation.

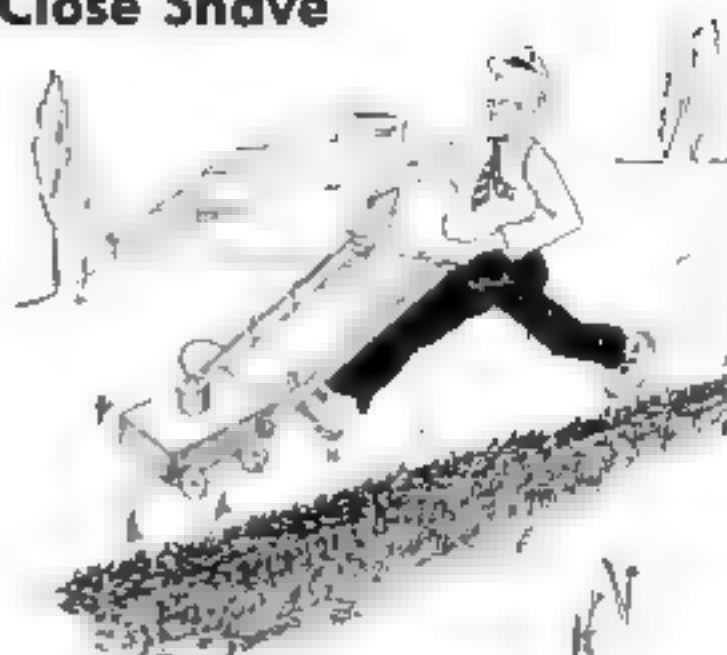
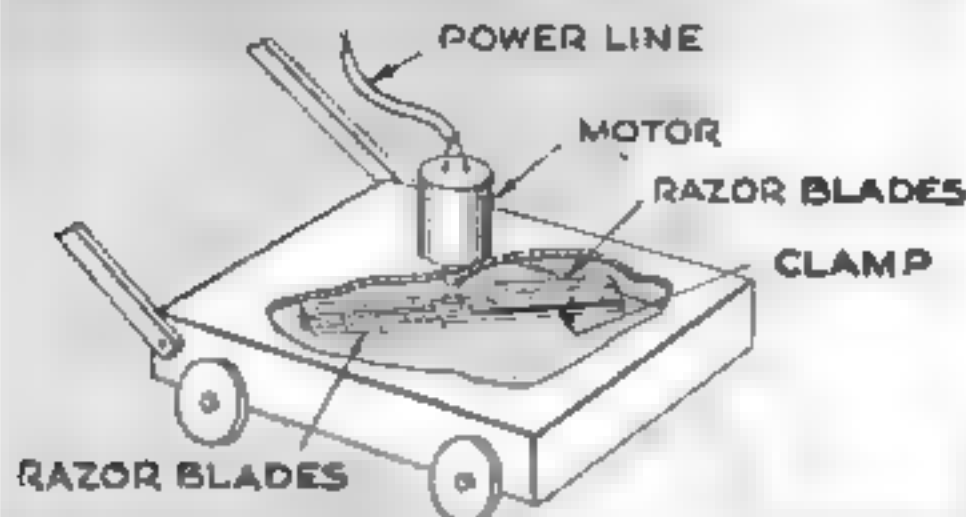
WASTED TAXI MILES, estimated at a billion a year, may be substantially reduced through use of a two-way radio dispatcher. First tested by the Yellow Cab Co. in Cleveland with Motorola equipment, the idea is proposed for other cities to save tires, time, and temper as well as fuel. Petitioning the

FCC for 30 operating channels in the FM spectrum, the National Association of Taxicab Owners pointed out the additional usefulness of radio taxis in reporting fires, accidents, and the like.

Rated high among the new ideas for postwar radio development, house-to-auto communication has as many potential applications as the radio waves allow. Doctors' cars and emergency vehicles top the list.



Motorized Razor Blades Give Lawn a Close Shave



A NOVEL use for discarded razor blades has been reported to the Marlin Firearms Company, of New York, makers of Marlin blades, by C. D. Tuska, of Philadelphia.

Marlin had run an ad showing a hot gentleman with a lawn mower. He was asking: "Why can't someone invent a lawn mower with Marlin blades?"

"They have," wrote Tuska, who noted that this provided a double use for blades. He sent along this cartoon by Forrest Greswold, and described his device thus:

"As a practical matter, an old vacuum

cleaner motor was mounted on a boxlike structure. A rotor was attached to the shaft of the motor and arranged to support three blades on both arms. The blades, which are clamped in place, turn with the rotor at high speed, cutting off the grass neatly and cleanly. The cord for supplying power to the motor is no more troublesome than the electric cord of any vacuum cleaner.

"The razor blades withstand anything except stones and heavy twigs."

(P.S.M. would like to hear how readers make out with this.—The Editors.)

Lasting Repairs Help to Salvage Neglected Screen-Door Frames

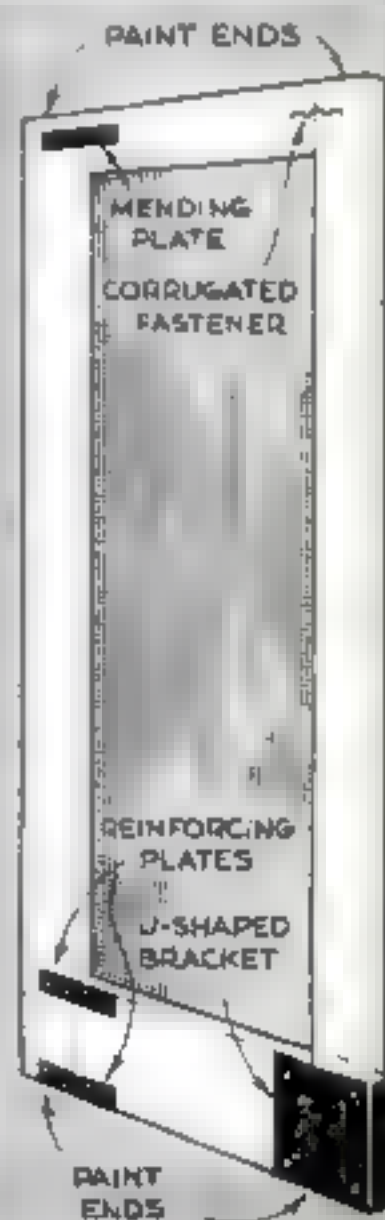
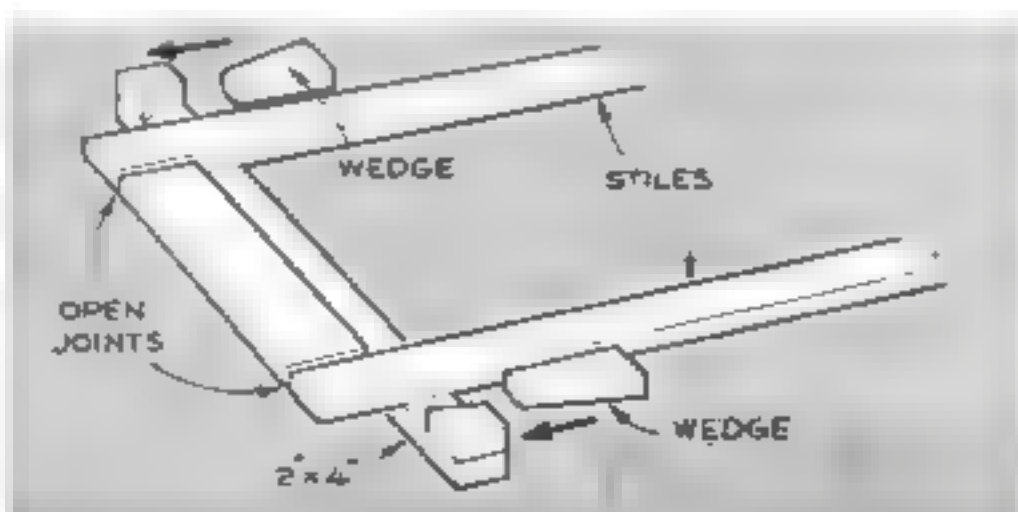
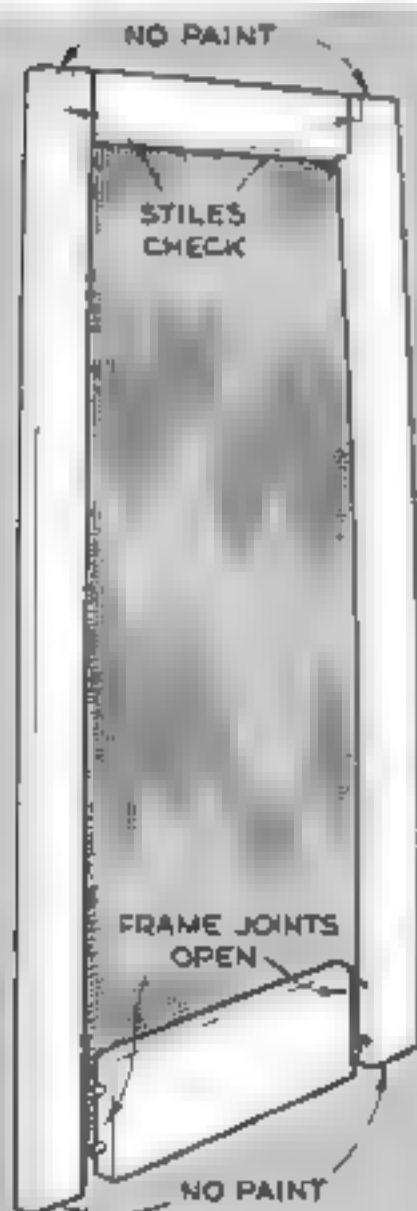
IF YOU neglect painting the top and bottom edges of screen doors, the open grain of the stiles will absorb water like blotters. Eventually the water will loosen the glued

dowels, causing the joints to open, and the stiles will check or crack.

If the joints of such a door have become loose, unhinge the screen and place it flat on a length of two-by-four running cross-wise to the door. Nail two tapered blocks to the two-by-four, one just beyond each edge of the door, as shown below. To close the joint, drive a wooden wedge be-

tween each block and the edge of the screen. Hold the joint snug by using corrugated fasteners, standard mending straps attached with screws, or homemade mending straps and nails, as shown in the drawing at right.

A stile that is badly split can be anchored to the rail with a piece of tin or galvanized sheet iron bent into a U-shaped bracket and nailed both to the rail and stile, as indicated at lower right-hand corner of the drawing. Such a plate should outlast the door itself. It will hardly be noticeable if it and the frame are painted the same color.—C. K.



Meet

KENNETH SWEZEY

KEN Swezey was born in Brooklyn and still lives there. His science interests began at nine, when he built a wireless receiving set. Later, he set up a chemical lab in the kitchen, using a grandfather-clock case as a cabinet and buying his supplies at the local drug store. He sold his first science article at the ripe age of 11.

At 14 he quit school—substituting book study and personal research for regular classroom instruction—and started teaching radio theory in a local Y.M.C.A. Three years later, he was technical editor of the *Radio Globe*, a special supplement that was published by the old New York Globe.

He has always been avidly interested in people who are doing things; for example, Nikola Tesla, the electrical genius who fathered alternating current, was a close personal friend of his.

For the past 22 years, he has been a free-lance writer and photographer. At least 1,500 articles by him, ranging in subject matter from goat raising and electric ship



propulsion to love and the fourth dimension, have appeared in various newspapers and magazines.

He says that he enjoys preparing home-chemistry articles for P.S.M. because it helps him to realize some of the unfulfilled dreams of his childhood chemistry days, when money, chemicals, and apparatus were all too scarce to satisfy his intellectual curiosity.

Synthesizing Rubber in Your Home Lab

By KENNETH M. SWEZEY

IF THE ancient sage who contended that you "can't make a silk purse from a sow's ear" could glimpse a few of the modern miracles worked by chemical synthesis, he might change his mind and decide that almost anything is possible. Materials even more commonplace than pig's ears are now constantly being transformed into completely different substances of far greater value than their constituents.

For instance, polysulphide rubber, a widely used rubber substitute, utilizes just a few simple chemicals. You can make it right in your own laboratory at home. It is doubtful whether your experiments will yield new tires for your car, but the product that you obtain will look and feel like natural rubber, and, if you wish, it can be turned into a ball or used as a pencil eraser.

Under the trade name of Thiokol, polysulphide rubber was the first type of synthetic rubber produced in the United States. Not

only has this synthetic all the bounce and stretch of natural rubber, but it is far more resistant to oil, gasoline, and other organic solvents.

What's it made of? Just a dab of sodium hydroxide (lye), a dash of sulphur, and a dribble of ethylene dichloride (a liquid no more exciting-looking than water)—all chemicals that have about the same relationship to the finished raw rubber as the sow's ear does to milady's silk pocketbook.

A detailed description of the technique of commercial manufacture of Thiokol is impossible at present because that would be giving away trade secrets and violating military security regulations imposed by the War Department, but enough can be told to enable you to demonstrate the fundamentals.

The objective in making all types of synthetic rubber is to cause the small molecules of thin solutions to link themselves together and form big molecules of rubberlike consistency. This process is known as *polymerization*, a word derived from the Greek

and meaning joining of many parts. Sodium polysulphide and ethylene dichloride provide the small molecules that become linked together when polysulphide rubber is produced.

Your first step in synthesizing rubber is to make a quantity of sodium polysulphide. Measure 150 ml. water into a beaker and dissolve in it 10 grams sodium hydroxide (ordinary lye will do). Heat this until it boils. Then add slowly, while stirring vigorously, about 20 grams flowers of sulphur. This substance is hard to wet, but persistent and vigorous stirring will win out. The solution will change gradually in color from light yellow to dark brown as the sulphur reacts with the sodium hydroxide. This darkening is an indication of the increase in the sulphur content of the polysulphide. The reaction will have reached its limit after 10 minutes of boiling and stirring. Then you should allow the solution to settle and cool. Finally, pour off the dark brown liquid into another beaker, leaving the unreacted sulphur behind.

Ethylene dichloride, sometimes called merely ethylene chloride, is the second major constituent of polysulphide rubber. It is an oily organic liquid that does not mix in the ordinary sense with any water solution. Therefore, it can be held in contact with the solution of sodium polysulphide only in the form of a physical suspension produced by a constant and vigorous agitation.

Such physical suspension can be attained a little more easily by use of a few grains of some chemical known as a *dispersing agent*, a compound that helps to keep groups of particles of substances apart by neutralizing their cohesive attraction. In this experiment magnesium hydroxide can be used as the dispersing agent. Add it to the solution of sodium polysulphide before proceeding to the ethylene dichloride step.

If you do not have magnesium hydroxide on hand, you can make this compound by adding a solution of sodium hydroxide to a solution of magnesium sulphate (Epsom salts) until precipitation stops. The precipitate, which is only slightly soluble in water, settles slowly. After it has fully settled, pour off the upper clear liquid and add fresh water. To wash the chemical, repeat this settling and pouring-off process several times; then let the remaining water evaporate. A white powder will remain. This is the magnesium hydroxide you need.

Stir a little of this powder into your solution of sodium polysulphide and reheat the solution to about 70 deg. C., checking the temperature with a thermometer supported in the beaker. Keep the thermometer in place throughout the remainder of the experiment and watch the temperature closely so that it does not get too high.

Now comes the ethylene dichloride. Slowly add about 30 ml., stirring constantly and very actively to disperse the liquid throughout the sodium polysulphide solution. The

7 If properly combined, these chemicals—sodium hydroxide, sulphur, and ethylene chloride, also known as ethylene dichloride—form a synthetic rubber now in wide use. It can be made at home.





2 As the first step in synthesizing rubber in a home lab, measure 150 ml. water into a beaker and dissolve in it 10 grams sodium hydroxide. (Ordinary lye will do.)

3 Bring the solution to a boil. Slowly add 20 grams flowers of sulphur while stirring. Sodium polysulphide results.

5 As the mixture cools, yellowish particles will settle to the bottom. Pour off the upper liquid and add water, repeating this several times.

6 And here it is—raw synthetic rubber. A small quantity of acid added to the solution causes minute particles to coagulate into a solid mass.



ethylene dichloride starts reacting with the sodium polysulphide immediately. Since this produces additional heat the thermometer must be watched carefully to keep the temperature of the mixture from rising above 80 deg. C., which is close to the boiling point of the organic liquid.

Continue stirring the mixture. If the particles are not well dispersed, lumps of a yellowish soft material may be encountered by your stirring rod. The color slowly changes from a transparent dark brown to an opaque lighter shade of brown. Keep up

the stirring for 15 minutes. Then turn off the heat and let the mixture stand.

As it cools, minute particles of a yellowish rubbery material will settle slowly to the bottom. When the mixture has fully settled, pour off the upper clear liquid, as in making the magnesium hydroxide, and refill the beaker with plain water. Repeat, as before, until the water is almost colorless.

The material at the bottom by this time may have coagulated into a mass. If it has not, add several drops of phenolphthalein solution. Because of the presence of a little



4 Pour the brown liquid into a second beaker and add about 30 ml. ethylene dichloride while keeping a check on the temperature.

7 Squeezed into a firm ball, the synthetic will bounce like natural rubber. It stretches and can be put to practical use as a pencil eraser.



alkali remaining, this will cause the liquid to turn pink. Now add dilute hydrochloric acid, drop by drop, until the pink color disappears. After the color has gone, add several more drops to make the liquid slightly acid. This acidification of the solution breaks down the repulsion between the particles of polysulphide rubber and causes them to coagulate into one irregular mass.

Take out the mass, rinse it, and squeeze it into a ball. What you have is a blob of real, raw synthetic rubber with about the consistency of an eraser. It will bounce, although not too well, and you can stretch it considerably before it breaks.

Commercially, this raw synthetic is used just as the starting point for producing finished rubber for many different purposes. It can be worked on a rubber mill in the same manner that natural rubber is worked. If the raw plastic mass is intimately mixed with zinc oxide and heated to about 140 deg. C., a transformation occurs similar to the vulcanization of natural rubber.

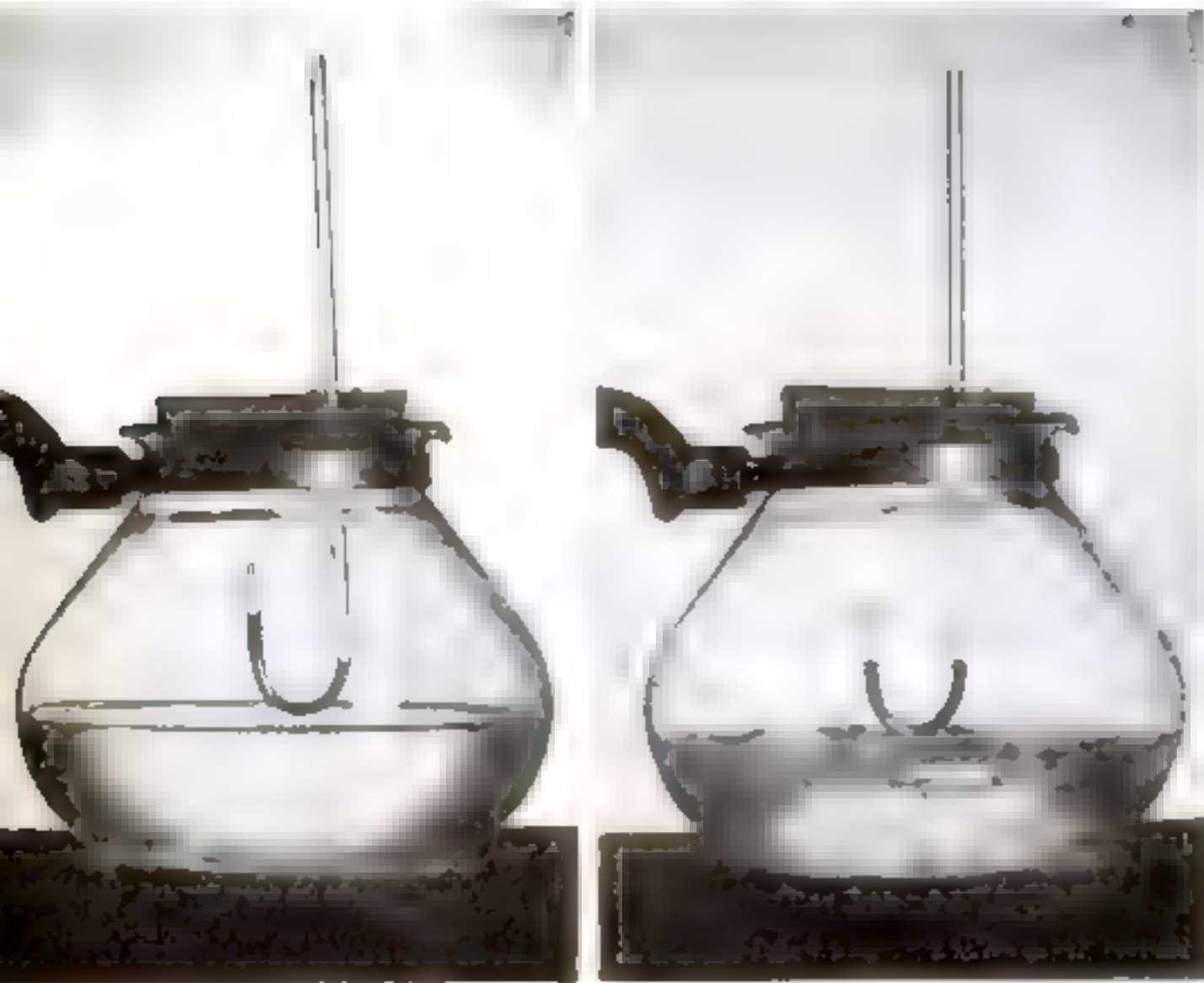
The war has given a big boost to the development of synthetic rubber. By their swift thrusts into the Southwest Pacific, the Japanese gained possession of the bulk of the world's supply of the natural product soon after Pearl Harbor. The Allied nations thus were forced to look elsewhere.

Chemists got busy, working against time in order to replenish the dwindling rubber stock piles. How well they succeeded is indicated by announcements early this year that synthetic rubber is here to stay.

Magnesium hydroxide, used in dispersing ethylene dichloride in step No. 4 above, can be made with sodium hydroxide and magnesium sulphate solutions.



HOME EXPERIMENTS DEMONSTRATE

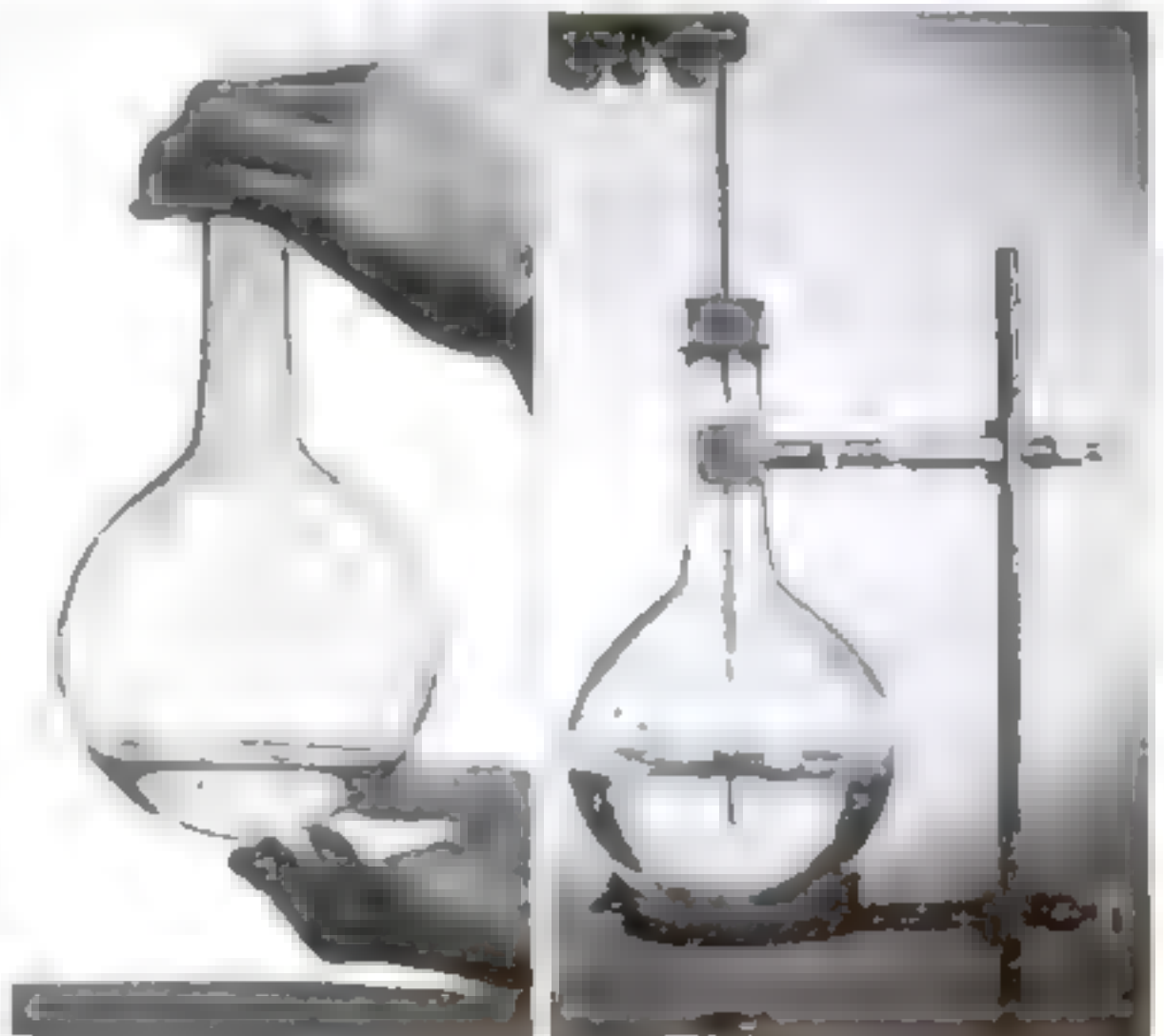


other vapor accordingly form in the liquid. To prove that vapor pressure at the boiling point equals air pressure, bend up one end of a glass tube and seal the end. Place mercury in the tube so that it fills the short leg completely while standing considerably lower in the longer leg. Then add several drops of water to the tube, manipulating it so that they rise in the shorter leg. Mount the tube nearly touching the surface of water that is slowly brought to a boil. As the temperature rises, the water trapped in the tube is also heated, which causes its vapor pressure to increase, forcing the mercury into the longer leg. When the boiling point is reached, the mercury will stand at equal

HEATING A LIQUID increases its vapor pressure and hence its rate of evaporation. The boiling point is reached when the vapor pressure of the liquid equals atmospheric pressure, and when bubbles of steam or

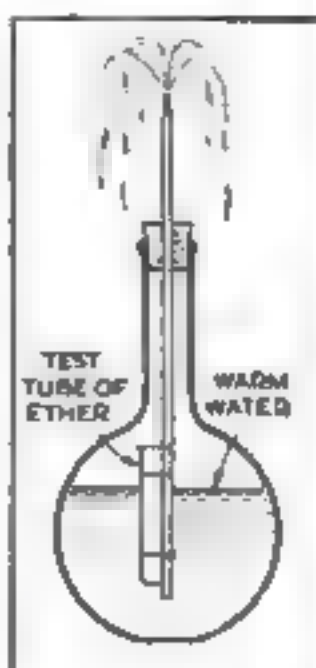
height in both legs, with vapor pressure of the water in the shorter leg exactly balancing atmospheric pressure on the other. If you use a stopper to support the bent tube, make sure it does not close the flask.

PRESSURE on a liquid determines its boiling point. Put a little water in a round-bottom flask and bring to a boil. Then remove the flask from the heat and stopper it tightly as soon as the steam subsides enough. The boiling will continue for minutes; condensation reduces pressure so much that the boiling point drops considerably. To show that the reverse is also true, use the arrangement at the far right with a thermometer thrust through a one-hole stopper. With the flask not stoppered, no amount of boiling will raise the temperature above 100 deg. C., but if you hold the stopper down for a moment, the temperature will rise. *Do not hold the stopper down for long, and use a round-bottom flask in both experiments to provide greater resistance to pressure.*

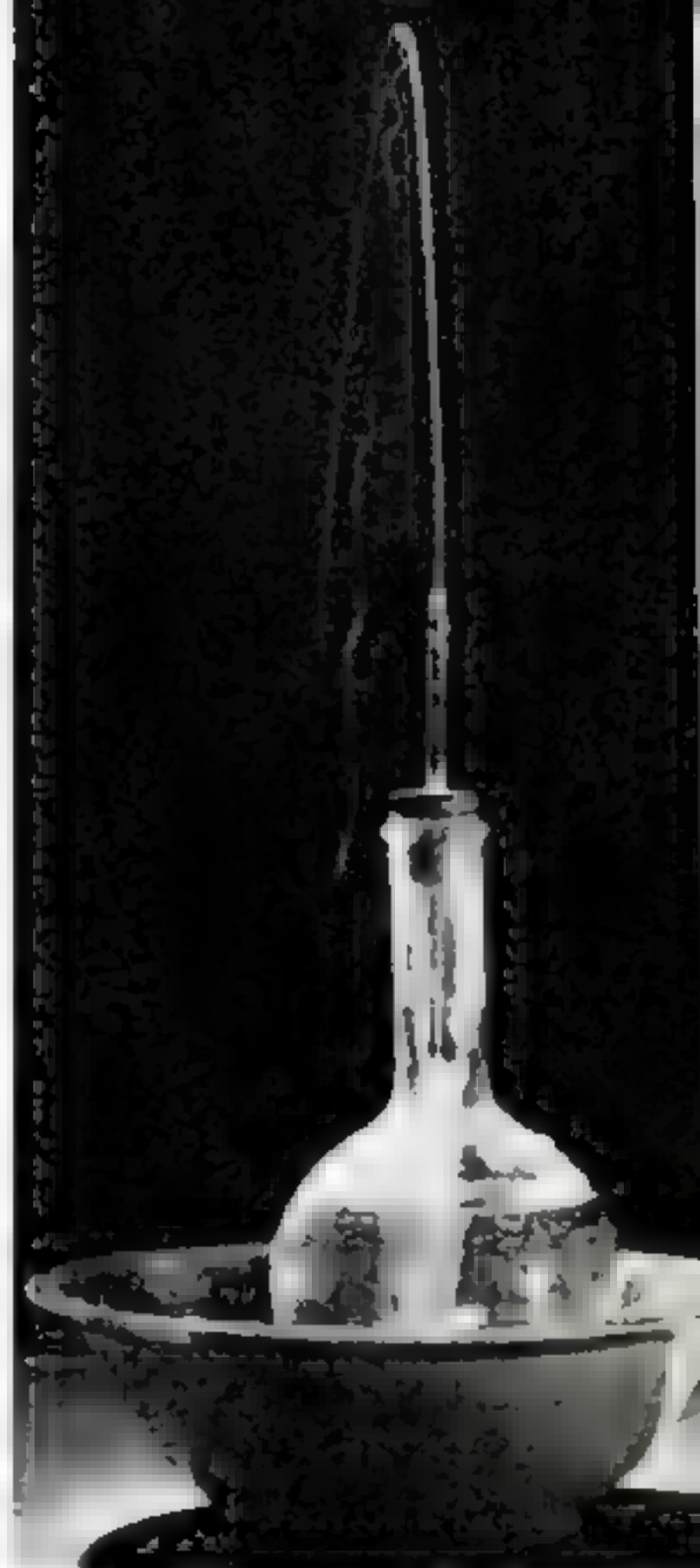


VAPOR PRESSURE

ETHER BOILS at less than 35 deg. C., and has a high vapor pressure at considerably lower temperatures. This enables one to perform an interesting stunt. Draw a straight glass tube to a jet at one end and thrust the other through a stopper which fits a flask or bottle. Tie a small vial of ether beside the lower end of the tube. Pour lukewarm water into the bottle and insert the stopper. The vapor pressure of the ether increases as the water warms it, forcing water up the tube. In a few seconds water begins spraying from the jet as in the photo at the right.



BLOW THROUGH a test tube containing a little ether, and the rapid evaporation of the liquid absorbs enough heat from the tube and surrounding air to freeze the water vapor in the air. This demonstrates the fact that when molecules of vapor escape from a liquid, heat is robbed from the liquid and its surroundings. It takes 540 calories of heat, for instance, to turn 1 gram of water into vapor at 100 deg. C. Be sure to perform this experiment, as well as the one above, on a porch or other open place, away from any flames, for ether vapor is highly inflammable and explosive.



LIQUIDS INCREASE in volume while standing, instead of evaporating, if they are water-soluble and have a lower vapor pressure than the usual vapor pressure of the atmosphere. Two such liquids are concentrated sulphuric acid and glycerine. Another is ethylene glycol, a nonevaporating antifreeze. You can demonstrate this quirk by placing two identical small vials under an inverted glass, one filled to the half-way mark with water and the other to the same level with sulphuric acid. As the days pass, the water diminishes and the acid increases in volume. If they are left long enough, the water will transfer itself completely.

This rugged-looking farm tractor had at least two previous starts in life—one as a 1928 Whippet and the other as a Ford truck. The Whippet donated the transmission and engine and the Ford contributed a heavy auxiliary transmission and worm-drive rear end. This is just one of many tractors built from salvaged parts by Robert K. Chess. It has an integral plow hitch with power lift, a power take-off, and also a mowing-machine attachment.



One-Man Tractor Factory

FARM equipment built to order is the specialty of Robert K. Chess, who runs a small welding and machine shop in Kelso, Wash. War-created shortages have only served to increase his business. In addition to his regular work of servicing and repair-

ing farm implements, Chess now finds a big demand for tractors and other machines built entirely from salvaged and homemade parts. His shop also turns out such devices as governors, power take-offs, power plow lifts, and hitches.

Two Fords provided salvaged parts for the tractor shown below. From a Model A came its motor and transmission; from a truck the secondary transmission and worm-drive rear end. A hydraulic lift for the plow hitch is driven by a fan-belt gear pump, and there are a power take-off and a winch.



Two views are shown above of another tractor built by Chess in his one-man shop. This one has a Durant 4 motor with a roller-chain two-to-one reduction drive from the clutch shaft to its single heavy four-speed truck transmission. Its worm-drive rear end is from a Ford truck. The close-up shows the air cylinder that powers the plow lift from the engine manifold vacuum.

At left is a lime spreader and broadcast seeder built from a Terraplane rear end with the shaft vertical to drive a four-blade fan wheel. A transmission gives two speeds for the turntable as well as a neutral position.



How We Keep Warm

(Continued from page 126)

figures, that a normal human produces enough heat to keep a 100-watt light bulb burning, if that heat were translated into electricity. This is the output when one is at rest. It jumps to 300 watts when one is taking a fast walk, and shoots up to 1,000 watts in a strenuous effort, such as a 100-yard dash.

How important are such figures? Well, consider that men on high-altitude bombing missions must sit comparatively still for hours in temperatures as low as 70 below zero. Their uniforms naturally must be very different from those provided for soldiers fighting in zero and below-zero temperatures on the ground.

The surface temperature varies in different parts of the body, and scientists can give us exact figures for this, too. Here is how a man stacks up under just one set of conditions. He is dressed in ordinary clothes and is sitting comfortably in a room of 70 degrees. These will be the temperatures of his body parts:

| | |
|-----------|----|
| Head | 91 |
| Torso | 94 |
| Arms | 92 |
| Hands | 90 |
| Buttocks | 92 |
| Upper leg | 91 |
| Lower leg | 90 |
| Feet | 80 |

It's perfectly normal, then, to have relatively cold hands and feet, even in a warm room. When it comes to exposure to extreme cold, it is vitally important that the hands and feet be cold—far colder than the torso. This is one way in which nature protects human life, for we can endure much more cold in our extremities than in the body proper. When the hands and feet get very cold, the blood is driven out of them by constriction of the many small blood vessels. This blood is thus shunted to the torso for use of the vital organs in the emergency—the organs that must keep working if we are to live. Nature's logic carries this idea to such an extreme that one's toes and fingers may be frozen off, yet one will survive because these parts were robbed of warming blood to save the main works.

Experiments have proved that a person's feet may be chilled to 70 degrees without too much discomfort. On the other hand, the person whose hands and feet remain warm under low temperatures is not so fortunate as he might imagine. For his general well-being it would be better for this heat to be produced in the part of the body that houses the vital organs. There is scientific

justification, then, for the old saying, "Cold hands, warm heart"—though there is no sentimental value in the fact, only physiological.

Also, scientists will tell you it is not bad to shiver; quite the contrary. Shivering is another way nature has of taking care of you. When the surface temperature of the body drops a few degrees, shivering starts automatically. It is a form of exercise, involuntary muscular activity that produces extra heat just as if you had walked or run. Experiments have shown that this shivering increases the body's heat production as much as 100 percent. It's a lifesaver in an emergency.

A popular fallacy scientists would like to destroy is that clothes warm the body. What our garments really do is prevent the body from losing too much of its own heat. The problem of keeping warm is simply a matter of insulation. The clothes that prevent heat from escaping are the warmest. Even our airmen's suits, which are heated by electricity, are not designed to warm them, but to help their bodies retain heat.

Armed with all the knowledge they had previously gained by many experiments, the scientists created the copper man with a heating apparatus closely resembling that of the human body.

Several dummies have been in use by laboratories throughout the country, but the most recently completed copper man is in the Fatigue Laboratory at Harvard University. Presenting a number of improvements over previous models, the physiological characteristics of this dummy were specified by Dr. H. S. Belding after consideration of many experiments at the Harvard laboratory on the effects of cold climate and high altitude. The relative technical perfection of the copper man is credited to the manufacturer, the General Electric Company, and derives in no small measure from its pioneering experience in the manufacture of electric blankets and, later, of electrically heated flying suits for the Air Forces.

The robot was electroplated to a thickness of about a sixteenth of an inch on a wax model of the "average Air Forces man." The wax was then melted out. To give every part of the copper skin the prescribed temperature, electric wires of the proper resistance and length were sewn into fabric and cemented to the inside of the skin. Through these wires a known amount of heat can be fed to all parts at once. Thermocouples attached to the skin permit reading of temperatures at 15 points. Copper was used because of its high conductivity, which dis-

tributes the heat evenly among the wires to the whole skin.

Heat input to the copper man can be controlled electronically to maintain skin or internal temperature at any desired level, with the actual heat input measured continuously by a sensitive watt-hour meter.

The heat input to the copper man is thus adjustable to simulate the heat production of a man engaged in any activity. The heat is distributed over the body in the proportions that were found proper for a man sitting in a room at 70 degrees. However, so important is the relationship of hand and foot temperatures to the rest of the body that the copper man was provided with special variable transformers for his hands and feet. By varying the current to his extremities the scientists hope they can closely simulate the reactions of the human body when the hands and feet become cold or warm.

The copper man has a human temperature but no human temperament, and that fact endears him to the scientists. His reactions are not complicated by emotions or lowered vitality. Human emotions affect the temperature of the hands and feet especially. Different men react differently under like conditions, and the same man will give dif-

ferent reactions from day to day. The robot, in effect, is a thermometer shaped like a man—the perfect “guinea pig.”

The matter of size is important, for the scientists know a small body loses its heat faster than a larger one. That is why a horse's heart beats only 30 times a minute, as compared with 75 for the average person and 1,000 for the mouse. So the copper man was made to the American flyers' average height of 5 feet 10½ inches, and his proportions are those of a well-built young man. He was first modeled in clay, then cast in wax. The wax figure then was coated with a special varnish so that it could be electroplated with copper to produce a skin of even thickness all over. This done, the wax was melted out. The clay model may be used again and again to produce more robots of the same kind.

It is the copper man that has made possible the testing of insulating values of fabrics with exactness never obtained before. Researchers figure that the statistics he gives are within two percent of absolute accuracy. His usefulness thus will continue long after he has served his primary purpose of helping to give more scientific protection to our fighting men, with added comfort and efficiency.

How Good Is the Jap GI?

(Continued from page 123.)

garment cutter in New York City, noticed this Jap tendency to be slow on the uptake when he was assigned one day on Bougainville to go with another American soldier 3,500 yards out front of the lines to throw a road block across a Jap trail. For two days Porretto's rifle picked Japs off on the path. He killed nine for sure and thinks he may have accounted for a tenth. The two riflemen's position was surrounded by Japs on three sides. If the Japs had come after them through the gully beside them, even two companies could not have held the position, but somehow the Japs never seemed to figure it out.

The same thing was observed on a larger scale during the fighting at Rendova. A dozen Long Toms—155-mm. rifles—were plastering the Japs on New Georgia across the way. The Japs over there must have radioed for planes to knock out the cannon, for presently 16 showed up and made for the guns. But then the Jap inability to take advantage of a situation showed up. As the planes came in, they observed a surprisingly juicy target on the waters of the bay below them—eight bulky, cumbersome LST's and 22 slim LCI troop carriers. Ignoring these soft touches, the Japs blindly headed for

the guns, despite the fact that it was obvious it would be far harder to spot the cannon ashore and that there would be so much less return possible for every bomb. The end result was that planes got neither ships nor guns and all 16 planes were shot down—12 by ack-ack, the rest by planes.

Perhaps as part of the Jap inability to think well on much more than a man-to-man scale, the Jap service of supply in the South Pacific never compared with the American supply system, despite the fact that the Jap lines were much shorter. Of course, American production tipped the balance in our favor, too. At any rate, on Bougainville all that Jap supply was able to get in to their men was some ammunition, an inadequate amount of rice, and a few other items. For a major part of their food, the Japs had to depend on gardens that they carved out of the jungle and on fish brought in by special fishing units, Jap GI's assigned to that detail. On Leyte there were evidences that the same thing was true, although Japanese supply lines there were much less harassed by American planes and PT boats than were those on Bougainville. Filipinos told us after the landings that the Japs took their livestock

and even confiscated native clothing. When the Japs first hit Leyte, the invaders were in ragged clothes, but after a while it was the Filipinos who were in tatters.

Such a poor system of supply works to the disadvantage of a war machine, of course. In San Pablo on Leyte I saw a Jap strong point that had been abandoned half-built. The floor was in and the steel reinforcing rods for the walls stood forlornly in place, but the walls themselves were up only 12 inches when the American landings interrupted the proceedings. To do the job the Japs had only three broken-down old wheelbarrows. American heavy gear, provided by the American system of supply, would have done the job in a matter of days, in ample time to resist the invaders.

In artillery, the gulf between the Jap GI's and American GI's was particularly wide.

The Japanese artillerymen seemed to operate on the theory that they had to be sparing in the use of shells. American artillerymen, on the other hand, would fill the air with missiles when an artillery duel began. One night the Japs opened up with three 75's and two 155's on Bougainville. They lobbed in 100 shells. American guns spoke back with 2,000 rounds. The five Jap guns were not heard from again.

"About the time the Japs get on us," said one 37th Division infantryman, "they stop." A half dozen rounds often were considered by the Japs in the South Pacific as enough to take care of their objective. American artillerymen felt that more than that were needed just to clear away the jungle at the target. Whenever American artillery on Bougainville began firing, a battalion concentration of a dozen guns would open up, three rounds a minute coming from the 105's and two a minute from the 155's. The theory was that "if it's worth doing at all, it's worth putting enough on." One night's firing left more than 2,000 actually counted shattered Jap bodies strewn across the target terrain.

The Jap artilleryman just never has thought of concentrating artillery in the lavish American fashion—or so it seemed at Munda, where excellently casemated artillery positions were found. The Jap guns were frozen into such positions that no two could converge their fire on the same spot.

On a few smaller items of gear the Japs did not have to take a back seat. The Jap GI uses much more leather goods than the American, and often has better sewing and similar signs of superior quality. Where an American's ammunition pouch will be of webbing, the Jap may have one of leather. Supplementing his peculiar split-toed foot-gear (a type constructed like a mitten,

with a separate casing for the big toe), the Jap may also have a pair of fine hobnailed pigskin shoes.

One item of Jap GI gear that has always interested American GI's is the bellyband they wear. At least, one American soldier told me one day on Bougainville, during the December rainy season, that he might like one of the bellybands himself "to keep the abdomen warm and to ward off dysentery and disease." I do not know of any Americans, however, who actually have taken to using the Jap-type bellybands! On his band, as a good-luck charm, the Jap GI has embroidery by his girl and autographs of other friends. Sometimes the Jap GI carries items none of the Americans can figure out.

Jap oddities on Leyte in the Philippines included wooden and paper bullets found at Tabontabon. The wooden-bullet cartridges were mounted on tin strips 15 inches long, in much the same fashion as machine-gun bullets might be assembled. They had only a 50-yard range, according to some American GI's who studied them. Perhaps they were intended for night infiltrations. The paper-bullet cartridges had a full powder charge and unraveled when damp. One theory was that they were just for practice. The wooden bullets, however, would splinter painfully.

However Americans might disparage various items of Jap gear, it was quite apparent that the feeling was not reciprocated. On Peleliu in the Palau group, the Japs showed so much affection for American gear that special American police details had to be sent out over the battlefields before dark to pick up carbines, automatic rifles, C rations, and other gear so that Jap GI's would not get them while foraging in the night. Many a Jap did get an American weapon, however, before the fight was over. Usually they knew just how to use them, too. An exception was the Jap GI who tried to fire a bazooka from the waist. He probably would have been killed by his own backfire, but the tank at which he was aiming riddled him before he could pull the trigger.

The familiarity of the Jap GI with American gear is not surprising, however, for his machine shops on Angaur in the Palau group were full of American tools, and his equipment on Leyte bore many an American trademark. Possibly it was material captured in Manila. Possibly it was stuff bought before the war. At any rate, the Japs on Leyte were using RCA radio equipment, Remington Rand ammunition, Ford V-8's, Lux soap, Chelsea cigarettes, and at least one Dodge bulldozer. The Jap GI may not like Americans, but he sure likes the good old American gear!

Rifles and Pistols in Five Wars *(Continued from page 115)*

this war. The older smoothbores were practically useless beyond 50 to 100 yards, and most battles were fought at close range with a good deal of bayonet and sword work involved. The Mexican Army, corruptly administered, was more poorly equipped than the American, and practically every type of shoddy foreign gun could be found on the battlefields.

The Mexican War brought home the fact that improvements were necessary in military firearms, and inventors were encouraged to go to work. The Civil War found the nation still trying to standardize its military firearms, however. Probably no conflict in history has brought together so many antiquated and modern—for the time—weapons. Flintlocks, muskets, rifles, repeating rifles, single-shot carbines, repeating carbines; flintlock pistols, "six-shooters," percussion single-shots, "pepper-boxes," and derringers faced each other at Bull Run and Cold Harbor, Gettysburg and Antietam.

The shortage of manufacturing facilities on both sides brought about the importation of foreign arms from Belgium, Germany, England, and any other nation that had military junk to sell. In the end, the industrial facilities of the North tipped the scales, and the South was defeated by Yankees firing guns said to be "loaded on Sunday and fired all week."

The Civil War spelled the doom of the muzzle-loader. After the battle of Gettysburg in 1863, some 20,000 guns were collected from the battlefield. Examination at an arsenal showed that anywhere from two to 23 charges were rammed down one on top of the other in a very heavy percentage of the weapons! It was quite apparent that breechloaders had to be developed, or half of the soldiers might as well be armed with sticks. Standardization also was decided upon, as investigation showed some 69 types of rifles being used, most of them calling for special types of ammunition.

For economy, many of the old muzzle-loaders were converted to breechloaders in the years following the Civil War. The same was true of pistols, although their development was ahead of that of the shoulder weapons.

In 1873 a new-model, single-shot breech-loader, which fired a cartridge .45 inch in diameter, was adopted. This weapon went through a series of modifications and was used until about 1892. During all these years, the Army was experimenting and

testing all types of military rifles and pistols that were being used elsewhere in the world.

Around the 1890's a board of Army officers decided to adopt the Norwegian Krag rifle as the standard infantry arm for the U. S. This was the first of the .30 calibers, or "pencil" bullets, as they were called. The rifle was modified in 1896 and used in the Spanish-American War.

In this war, the regular Army had the advantage over the militia and volunteers, who were largely armed with the older-model Springfields, which fired the old black-powder cartridge. Loud laments were heard every time a round was fired. A cloud of white smoke gave away the firer's position to the Spaniards, who cracked down with their superior Mausers and smokeless powder.

Following the successful conclusion of this war, it was decided that we needed a rifle incorporating the advantages of the Mauser with American refinements. The result was the now famous Model 1903 Springfield, which was the standard infantry rifle until the beginning of the present war.

A Filipino rebellion next occupied the Army, and it was found that the .38 caliber pistols in use did not have sufficient shocking power to stop the fanatical enemy. The result was the .45 caliber Colt automatic pistol developed in 1905, which was standardized with improvements in 1911. This gun was used through the First World War, and it is the standard side arm today, although some revolvers are still in use at the present time.

The First World War did not bring about any startling developments in rifles or pistols, perhaps because the need for large quantities of arms enforced standardization. Because we could not manufacture the Springfield rifle fast enough to equip our fast-growing Army, a large proportion of American infantrymen carried the British Lee-Enfield. Various types of automatic weapons were brought out.

America was ready for this war with the finest semi-automatic rifle in the world. It was the eight-shot, rapid-fire, accurate Garand. It was a rude shock to a Jap soldier to wait until five rounds had been fired by an American soldier and then charge with the bayonet, only to find that he still faced a loaded gun. Both the Germans and Japanese have attempted to copy this efficient weapon, but so far neither has been notably successful.

LIGHTER MOMENTS with **fresh Eveready Batteries**

dated



"Oops, Pardon Us, Ladies! Wrong Bench"

*Be a regular American—buy
War Bonds regularly.*

"EVEREADY" flashlight batteries are important equipment for the Armed Forces and the essential war industries. It requires the bulk of our entire production to meet their needs. That explains the present scarcity of these dependable, long life batteries for civilian use.

However, new and improved "Eveready" batteries will make their appearance after the war in ample quantities. These new batteries will reward you with an extra measure of service and dependability.



The word "Eveready" is a registered trade mark of National Carbon Company, Inc.

Buy War Savings Bonds and Stamps regularly.



FOR QUALITY

Choose the name you can trust in Rubber

● War has destroyed most peacetime yardsticks of tire value . . . and here's why:

All tires are now made from GRS (Government Rubber Styrene)—the soft plastic adopted for tire manufacture after Pearl Harbor. Therefore all manufacturers started at the same time, from scratch, to create the new techniques necessary to process GRS into serviceable tires.

Naturally, then, it is the skill of the maker—and skill alone—that determines the *quality* of today's tires.

Skill has always been the outstanding

ingredient of Seiberling Tires. That skill has grown inevitably out of Seiberling's honest determination to build and market fine tires—not to a price, but to perform.

That is why so many tire research achievements come out of Seiberling laboratories.

That is why Seiberling men—chemists, engineers, tire builders and dealers—are known as Experts in Rubber.

And that is why you can have complete confidence in today's Seiberling Synthetic Tire. It bears "*The Name You Can Trust in Rubber.*"

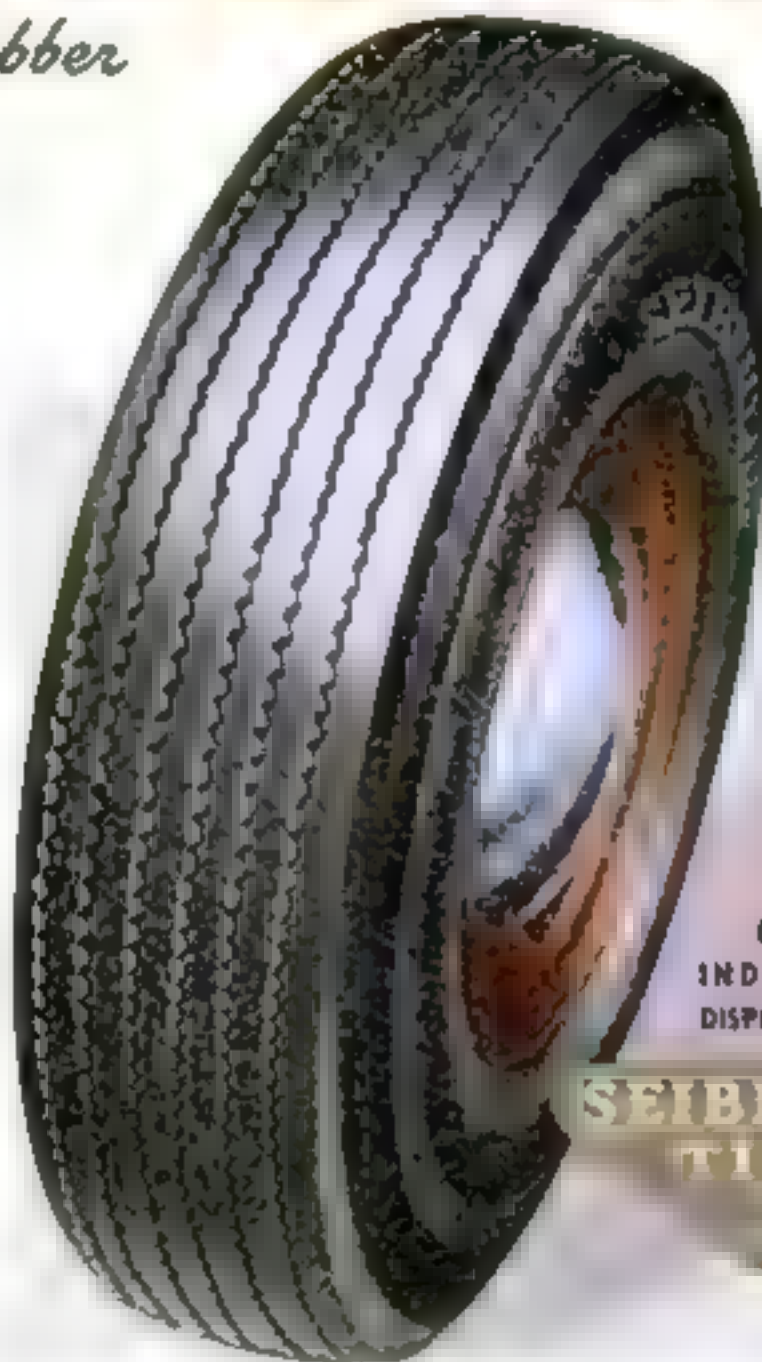
SEIBERLING

Experts in Rubber

THE BATTLE OF RUBBER IS FAR FROM WON!

This war is consuming tires at a rate so fast no one could possibly have foreseen it. One fighting unit alone requires 5000 in 24 hours. Help win the Battle of Rubber by making your tires last. And help win the Fight for Freedom—

**BUY BIGGER BONDS
IN THE
7th WAR LOAN!**



RETAILED ONLY BY FREE,
INDEPENDENT BUSINESS MEN
DISPLAYING THIS SIGN OF QUALITY

**SEIBERLING
TIRES**

It's an Engineer's War

(Continued from Page 96)

miracles performed by the Engineers for General Patton. There was but one railroad from Cherbourg to Paris. On August 13, he ordered another railroad opened to Laval and Le Mans within two days. This would have been a staggering order if he had said two weeks or two months.

It meant rebuilding seven bridges, removing the debris from demolished tunnels, relaying miles of bombed-out track, restoring water points, and putting three big, devastated, marshaling yards back into operation. Five regiments of Engineers tackled the task. To design new bridges, officers bent over drawing boards in tents pitched beside the bulldozers that were shoving the debris away—and the supply trains rolled forward on the 48-hour deadline. Eight months after D-day, the Engineer Service in France had completed the restoration of 7,000 miles of railroad lines.

At the same time, other Engineers were doing the construction necessary for running the remarkable Red Ball Express, a system of one-way truck routes from Cherbourg to the ever-moving front, and this transport system was being rapidly supplemented with portable pipe lines.

These POL (petroleum, oil, and lubricant) pipes are made of flat, steel strip, wound spirally like a soda-fountain straw. A four-inch line does the work of 230 2,000-gallon trucks, and a six-inch line will handle over twice that much. If a pipe is severed, the fuel is shut off by closing valves installed in the lines, but it's almost impossible to hit one of these olive-drab supply lines with a bomb from the air.

In France, an Engineer pipe-line crew was only 85 miles behind the first Americans to enter Paris. Lt. Col. Arthur Duncan Small, an officer in our War Plans Division, who supervised the development of the POL bulk-distribution system, is a very modest fellow. But when he saw 1,500,000 gallons a day flowing through the pipes from Normandy, he crowed: "Bring on the reporters! Now we've got something to talk about!"

But was that any more remarkable than shooting a pipe line through Burma's hills and canyons to China from India? The line from Calcutta to the heart of China is the longest invasion-type pipe line in the world, and it was laid at the same time that the Ledo-Burma Road was being hewn open.

I like the story about a Dutch East Indies native who was asked whether the Australians, Japanese, or Americans were the best jungle warriors. "Aussie, him good

jungle fighter," the man replied. "Jap, him good jungle fighter, too. American come, jungle go!"

That has been a key factor in America's swift advance in the Pacific. General MacArthur returned to Manila by turning beachheads in the wilderness into mighty military bases, from which more beachheads could be taken and converted into bases. There were more Engineers than infantry or troops of any other service invading Leyte on D-day. When the Engineers land, they stay until an old-timer can no longer recognize the place. The Japs are fanatical fighters, and our difficulties have become greater as we have approached Tokyo. But the Japs have not learned to save time and labor, as we do, by using heavy construction equipment.

Our ability to move dirt is one of our greatest advantages. Crawler-tractor shipments totaled \$90,000,000 in 1940, but were increased to \$300,000,000 last year. That's more than twice as much as Boulder Dam and its power plant cost. And, in the same four-year period, shipments of cranes and shovels were increased 300 percent, crushing plants 1,300 percent, and tractor-mounted winches 1,500 percent.

One American bulldozer can do the work of 1,000 men. It is the modern equivalent of the Mormon-board plow, the wooden, horse-propelled, land-leveling tool that was used to build the Union Pacific Railroad, and it is helping us build things abroad in wartime that would be breath-taking if constructed at home in peacetime. Someone has said, "You can do everything with a bulldozer but shave." Countless Engineers have raised the steel blades of these wartime jacks-of-all-trades and charged right into Jap gun nests.

Shaving obstacles away, however, is only part of the business of building bases. In addition to bulldozers, cranes, and dump trucks, the U. S. Engineers have mobile rock-crushing plants, mobile power plants, mobile water-purification systems, and even mobile map-printing plants.

Now, when the 'dozers and graders have leveled off and thoroughly compacted an airstrip, we can cover it overnight with PBS (prefabricated bituminous surfacing). This can be rolled out of a big machine that resembles a printing press, faster than a red carpet can be rolled out of a hotel doorway for a visiting celebrity.

The machine that lays the matting is called a "stamp licker," because its function is to soften the asphalt by applying a sol-

WINCHESTER

batteries make light of the dark *bullet-fast*

The help that Winchester batteries can give towards winning complete victory is still needed. But, as battle after battle is won, the need of this help will lessen. With peace Winchester flashlights and batteries will again be available. The day when you can have all of them that you want is, we hope, not too far distant. Winchester Repeating Arms Co., New Haven, Conn., Division of Olin Industries, Inc.



UNUSUAL LIGHTS THAT HAVE SERVED MAN...

When Pizarro invaded the Valley of the Incas in 1533, he found them using torches made from the Caoutchouc tree. The Incas also made torches of the wax taken from the trunk of palm trees. Contrast these with the brilliant, bullet-fast light you get from your convenient Winchester Flashlight and Batteries.



WINCHESTER



vent. The mat consists of burlap, impregnated and coated with asphalt, and a roll of it looks like roofing material. The machine moves from two to four miles an hour, paying out a continuous strip of mat 36 or 40 inches wide. This is overlapped to form a thin but tough, weatherproof, and dustproof coating over the earth.

The development of this surfacing, incidentally, is an example of the co-operation between the United Nations. PBS was a British idea, first proved feasible by the Canadians, then further developed at our Army Engineer Waterways Experiment Station, Flexible Pavement Laboratory, in Vicksburg, Miss. It has been nicknamed "hessian mat" after the Hessian immigrants who settled in Scotland more than a century ago and began weaving Indian jute.

Pierced-plank and square-mesh metal runways are still needed at many airfields, but PBS now has been used on more than 100 strips in France alone, and Brig. Gen. James B. Newman reports: "We still do not know how long hessian mat lasts, because not one field has failed."

Whole cities of standardized homes now stand on Pacific islands where there was scarcely a Robinson Crusoe before the war. Aluminum bridges, with decking so buoyant that it will support a truck even if every ponton beneath it is sunk, now span rivers that the enemy counted on to stop us. Engineer port-repair ships are endlessly repeating the miracle of Cherbourg. And pumping stations are speeding oil through lines from tankers to tank farms for greater fleets of trucks and planes than most Americans have ever seen. All these things are part of the arteries of war.

The poet who yearned to "grasp this sorry scheme of things entire" that we call the world and "re-mould it nearer to the heart's desire" thought he was describing the impossible. But that is almost literally what the Engineers have had to do. The threat to America having been global, our military engineering has been global, too.

We have been successful thus far because we had learned how to do these things before the war in this country, and because we have had the co-operation and help of our allies. The U. S. Army Engineers look forward to resuming such peacetime activities as building beneficial river and harbor and flood-control works. But victory must come first. The shafts and bases supporting our soldiers must be still strengthened and extended. Greater wonders than any performed thus far may yet be demanded of us. Only by greater sacrifices and more determined efforts can we speed the day when it will be possible to turn to the pleasanter tasks of peace.

Life hangs by such threads



WANTED: Something to keep flyers from freezing. So engineers developed electrically heated goggles, shoes, suits . . . Something dependable to guide pilots in fog and dark. So engineers devised electrically driven gyroscopic instruments . . . Something automatic to control airplane engine temperatures. And now comes an electrical control for this purpose.

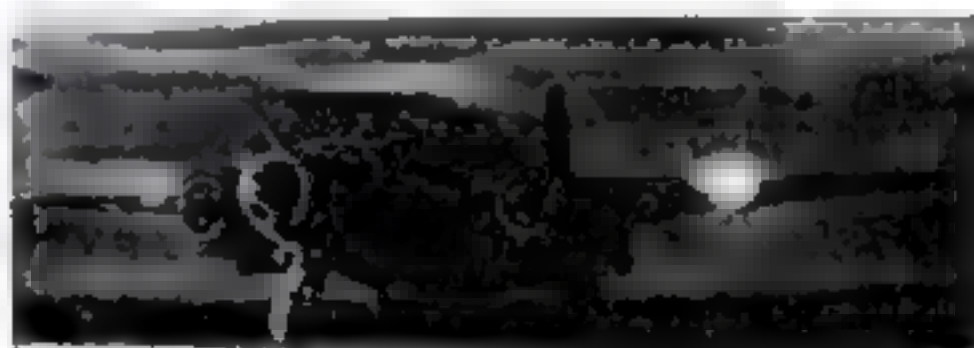
G. E.'s research and engineering staff has solved hundreds of such problems. The pictures here show how a few have been met. *General Electric Company, Schenectady, N. Y.*

© 1945 G. E. Co.



Flyers' lives often depend on their instruments. G-E workers use only tweezers to handle these precision parts of electrically driven gyroscopic instruments, dry them with air jets, oil them with hypodermic needles. They've got to be accurate.

Eyelids can freeze shut when you're 7 miles up! Electrically heated goggles, developed by G-E engineers, have fine wires embedded in plastic lenses. With G. E.'s electric blanket as a start, G-E engineers designed electrically heated flying suits, heated gloves and shoes now being made in three G-E plants. Toughest problem was to devise heated gloves with thin wires strong enough to stand constant flexing.



Making night landings safer. Engineers adapted the G-E "Sealed Beam" auto headlamps into war use—G-E airplane landing lamps 20 times brighter than those on your car. Sealed against dust, dirt and salt water damage, they cut down the peril of high-speed landing.

Hear the G-E radio programs: *The G-E All-girl Orchestra* Sunday 10 p. m. EWT, NBC—*The World Today* news, Monday through Friday 6-45 p. m. EWT, CBS—*The G-E House Party*, Monday through Friday 4:00 p. m. EWT, CBS.

FOR VICTORY—BUY AND HOLD WAR BONDS

GENERAL ELECTRIC



Blueprint of Happiness

THIS year *you* probably will not experience the great thrill that comes from poring over the blueprints for a home of your own. But we can tell you that your postwar home will be well worth waiting for!

● ● Yes... and today, while you're investing in War Bonds to help crush the Axis, remember you're also creating a nest-egg that will finance that home when you're ready to build it!

● ● The techniques of functional design and compact construction which enabled Defoe to build 137 fighting ships for the Navy since we entered the war, will be turned to producing quality-built homes after Vic-

tory. In addition to the economies of volume production, these new homes will introduce concepts of beauty and comfort, heretofore unknown in their price range—plus individuality of design and exterior treatment.

● ● Today, like ourselves, you have the double duty of performing your war-time task and buying your limit of War Bonds to hasten Victory.

● ● But *you* and *we* may both plan ahead around these scientifically designed homes that not only will offer greater dollar-for-dollar value to home buyers but will also contribute to better American living standards and full employment.

CORP. 1943 DEFOE SHIPBUILDING CO.

HOUSING DIVISION—DEFOE SHIPBUILDING CO.,

BAY CITY, MICHIGAN

★★★★★ Five White Star Bonuses!
Citations now decorate the Navy "E"
Award won by Defoe workers.

BACK THE ATTACK
—BUY WAR BONDS

Defoe

SHIPS FOR VICTORY
SERVANTS FOR PEACE

The hydraulic "midget" that helps rescue men at sea!

The U. S. Coast Guard had a good idea:

Why couldn't survivors at sea be rescued by helicopter?

With characteristic energy, they went to work. A hoist was designed which would lower a cable from a helicopter to a man on a life raft or in the water. The cable could be snapped to a special harness built into the man's life jacket.

But, when it came to finding a motor powerful enough to lift a heavy man quickly and smoothly . . . yet small, light, and controllable enough, they were almost stymied.

An engineer from Vickers Incorporated, a division of the Sperry



Corporation, suggested that a *hydraulic* system could do the trick.

"Go ahead and try it," said the Coast Guard. "And fast, please!"

Shortly, the Vickers hydraulic hoist was ready. It was powered by a midget motor—a *hydraulic* motor no bigger than a man's hand. A midget hydraulic pump supplied oil under pressure.

The whole installation was small, light, and *powerful*. That midget hydraulic motor could lift a 400-lb. load $2\frac{1}{2}$ feet per second. It could be started and stopped—even reversed—instantly but smoothly. And, without brakes or clutch, it held its load without slipping.

When the Coast Guard's good idea was demonstrated at sea before Government and Navy officials, it was a dramatic success. Four "survivors" were "rescued" from life rafts and transferred to a ship, in less than ten minutes!

What makes this midget mighty?

Modern hydraulics—the use of oil under pressure to drive and control mechanical devices—enables hydraulic motors to deliver



as much as $2\frac{1}{2}$ horsepower for every pound of weight! (Most airplane engines average not more than one horsepower per pound.)

Hydraulic motors also offer smooth operation, precise control, easy adaptability, simple, rugged construction.

Vickers manufactures a wide variety of these piston-type hydraulic motors. Also hydraulic pumps and controls for every type of hydraulic power application.

Their many advantages and economics suggest postwar uses in a wide variety of new equipment.

SPERRY

CORPORATION

30 Rockefeller Plaza, New York 20

FORD INSTRUMENT CO., INC.

SPERRY GYROSCOPE CO., INC.

VICKERS INCORPORATED

Waterbury Tool Division,

VICKERS INC.



It's a real SMOOTHIE

LATHE FILING embodies a distinct filing technique, and is employed to smooth-finish or true-up a shaft, spindle, hub, gear or other rounded part—usually to make it fit or rotate properly.

Lathe File vs. Mill File. Because of the 45° angle of its teeth, the Nicholson Long Angle Lathe File overcomes filing up and consequently scratching surface of work—a tendency common in the shorter-angle Mill file when used as a "lathe" file. The chips slide down the gullets and are forced out at the edge. Makes file self-clearing; provides cleaner shearing; prevents "chatter" and "drag"; assures faster cutting.

Further information—on proper use, and range of surface speeds for various metals—is available to machine-shop operators, master mechanics, home-shop "hobbyists." Ask also for handbook, "File Philosophy," on kinds, use and care of files in general.

NICHOLSON FILE CO., 19 Acorn St., Providence 1, R. I.
(In Canada, Port Hope, Ont.)

NICHOLSON
FILES FOR EVERY
PURPOSE

NICHOLSON
U.S.A.
MADE IN U.S.A.

The Reaction Engine

(Continued from page 74)

Since 1943, liquid-fuel motors have been developed that can be turned on and off at will, and that will operate for hours without burning out.

Liquid oxygen and gasoline have been used in much of the experimental work. This combination is more than four times as powerful as gunpowder and more than twice as powerful as the best smokeless powder. It can produce an ejection speed, theoretically, of more than 2½ miles a second. It is quite strong enough to shoot a projectile across the Atlantic Ocean if a motor can be perfected that will utilize the major part of the heat energy it contains. Liquid oxygen and gasoline is only one example, moreover, of many powerful liquid-fuel combinations.

Airstream engines also have vast possibilities. They may be either *thermal jet engines* or *duct engines*, and the latter may be either *intermittent* or *continuous duct engines*.

The thermal jet engine—often called simply a "jet engine," "turbo-jet," "jaypee," or "swish"—is the best-known airstream type. The Italian demonstration of flight by jet propulsion in 1940 was made with a somewhat primitive thermal jet engine. In England, Capt. Frank Whittle developed a much better version, which was brought to America for manufacture in 1942.

The Lockheed P-80 Shooting Star is propelled by a thermal jet airstream engine. The air enters through the wings, is compressed by a high-speed fan, and is admitted to a combustion chamber where it is mixed with the fuel. A continuous explosion in this chamber creates gases which then pass rearward through a turbine, which drives the compressor fan in front of the engine. In other words, part of the power of the jet is converted into rotary motion and used to pump air into the engine.

Duct engines do not have mechanisms to compress the air, so they are much simpler. But, since they depend at least partly on the compression or "ram effect" of the air during flight to provide them with oxygen for their fuels, they can be used only on aircraft or gliders that are given a fast start by some other source of power such as a catapult or a launching plane.

The V-1 bombs that were driven by a series of intermittent explosions had intermittent duct motors. Continuous duct engines, producing a continuous blast of power, are being developed now and may

(Continued on page 220)

PAN AMERICAN WORLD AIRWAYS



The Spirit of the Flying Clipper



PAN AMERICAN PRESTIGE BRINGS

NEW PRESTIGE TO

**CHAMPION
SPARK PLUGS**

In its far-flung operations to the outposts of the world, Pan American Airways has been operating under stringent wartime restrictions and equipment limitations. It has nevertheless compiled an outstanding performance record in both contract work for the Army and Navy and in maintenance of its own commercial routes.

This achievement bespeaks a painstakingly scientific maintenance and service program. The small but vital spark plug naturally came in for close study because of its direct bearing on engine economy,

performance, and dependability. Out of these studies and records emerged conclusive and dramatic evidence of superior performance, longer life, lower costs, lower maintenance and servicing time with Champion Ceramic Aircraft Spark Plugs.

The Champion Spark Plugs you buy for your car today are blood brothers to those used in Pan American's far-flying clippers. They are products of the same research and engineering, exclusive materials and processes; and, as a result, they bring an extra measure of performance and dependability to every engine.



To Save Gasoline—
Keep Spark Plugs Clean

CHAMPION SPARK PLUG COMPANY, TOLEDO 1, OHIO

PRECISION MEANS SUCCESS

In whatever they do — strafe, reconnoiter, dog-fight or bomb — fighter pilots must have pin-point precision for success. ★ It's that way, too, with the more-than-65,000 Allison engines which power their swift, high fighting planes. For it is precision in working with metals which gives Allison engines their great power, their smoothness, their low weight, their economy with fuel and their long range. ★ These qualities will be equally important in the planes you will enjoy in the future. ★ They are qualities born of the precision which will mark any product that ever bears the name Allison.

KEEP AMERICA STRONG
BUY MORE WAR BONDS

POWERED BY ALLISON

P-38—Lightning
P-39—Aircraft
P-40—Warhawk
A-36 and P-51A—Mustang
P-63—Kittyhawk

More than 65,000 Allison engines have been built for the above planes of the U. S. Army Air Forces.

LIQUID-COOLED AIRCRAFT ENGINES

Allison

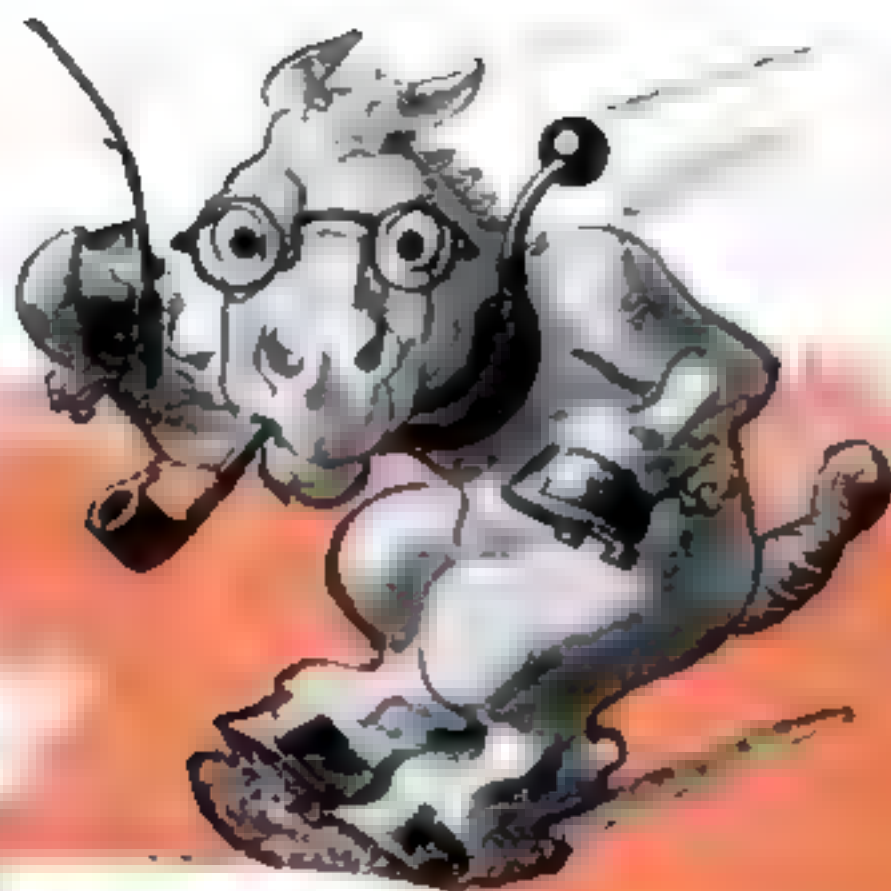
DIVISION OF

Indianapolis, Indiana

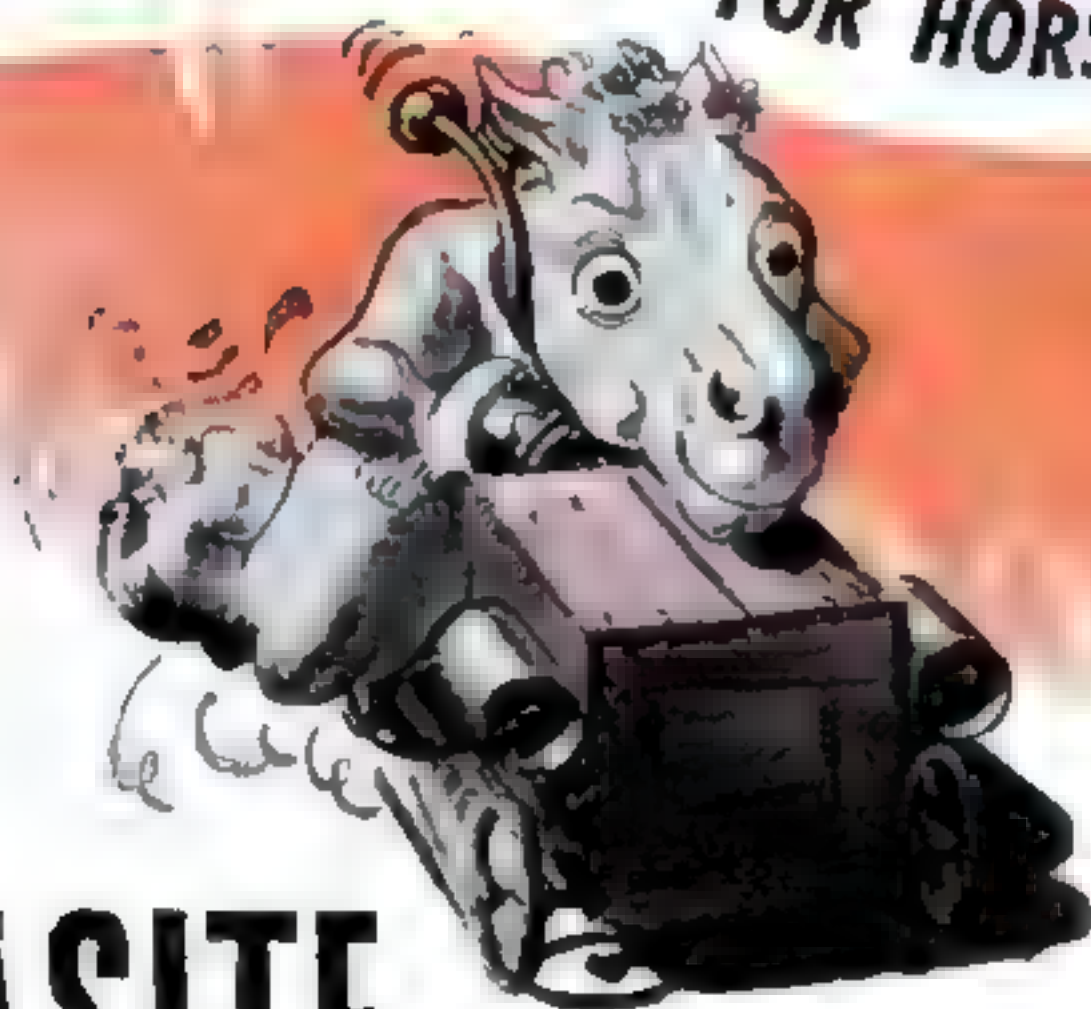
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Guarantees better and smoother performance or double-your-money-back

CLEANS OUT MOTORS • KEEPS MOTORS CLEAN

Dirty motors are lazy motors. Clean up, pep up, step up motor performance—with Casite. At your service station, car dealer or garage—a pint in the crankcase every oil change and a pint through the air intake every three months.

GUARANTEE — Add Casite to crankcase and run through air intake according to instructions, then drive your car 100 miles or for 60 days, whichever is first. If not convinced that Casite gives you better and smoother performance, you get double-your-money-back by filling out guarantee certificate and mailing to The Casite Corporation, Hastings, Michigan. Maximum refund is \$1.30 per pint. (See the nationally advertised price of Casite.)



65¢
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ACTION CENTER of any lathe is the cutting tool. Here all the power, speed and precision built into the machine focuses its productive performance. Here Williams Tool Holders will insure clean, chatter-proof cutting and uniformly high production. All Williams Holders are drop-forged, precision-machined and specially hardened. Their sturdy construction assures a long, accurate cutter seat. Write Dept. S-1 for your free copy of Williams Tool Holder Data Sheets, loaded with helpful information on grinding, setup and use of cutting tools.

J. H. WILLIAMS & CO.
BUFFALO 7, N. Y.



DROP FORGINGS AND DROP-FORGED TOOLS

The Reaction Engine

(Continued from page 216)

ultimately serve as auxiliary power plants for fast-flying aircraft.

About 1935, Bernard Smith, a member of the experimental committee of the American Rocket Society, developed a small reaction engine of the continuous duct type which he called a "blowtorch motor." Essentially, it was a tube open at both ends, into which a fine jet of burning gasoline was spurted through a small nozzle from a pressure tank. There have been no reports yet of full-sized aircraft being propelled by either intermittent or continuous duct engines but, if their efficiency can be improved, they may become full-fledged competitors of the thermal jet engines.

The power of a jet engine is not described in terms of horsepower. It is measured in pounds of thrust, and can be computed very simply. It is the product of the mass ejected multiplied by the velocity of the ejection. Hence, the thrust of a reaction motor can be increased either by increasing the volume of gas ejected in a given time or by ejecting it faster.

In a chemical-fuel motor, more fuel must be carried to increase the mass. This makes the motor heavier, and more energy must be spent lifting it. So chemical-fuel-motor engineers have striven, instead, to increase the velocity of the ejection of the gas as a means of increasing the power.

Better metal and plastic jackets, proper metal nozzles—and above all, better fuels—have made this possible in dry-fuel military rockets. The whole charge in a bazooka projectile, for example, goes off in a fraction of a second, while the rocket is traversing the length of the eight-foot launching tube from which it is fired.

The maximum jet velocity attainable from a fuel can be computed from its known energy content. A jet with a velocity of 7,000 feet per second can be obtained, for example, from gasoline and air, and one with a speed of 17,000 feet per second can be obtained from hydrogen and oxygen. A reaction motor in which such velocities were obtained would have maximum *thermal efficiency*. No reaction motor is that efficient, although reaction motors do utilize more of the energy of their fuel than the percentages used profitably by steam locomotives and automobile engines.

The *mechanical efficiency*, as well as the thermal efficiency, of an engine transforming chemical energy into mechanical motion must also be considered in deciding its use.

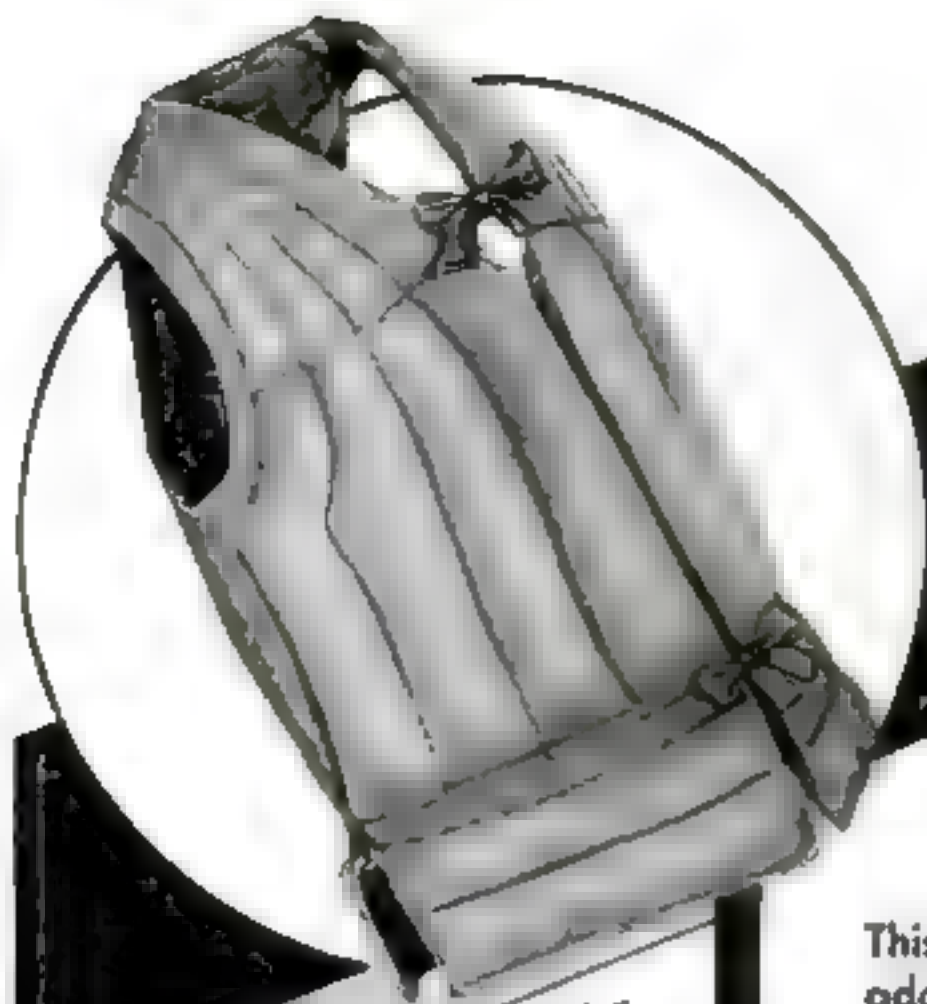
(Continued on page 224)



U. S. Navy's Grumman Night Fighters Hit Tokyo
F6F-5N Grumman Hellcats

Grumman

AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.



Safety

FOR YOUR Sports Afloat!

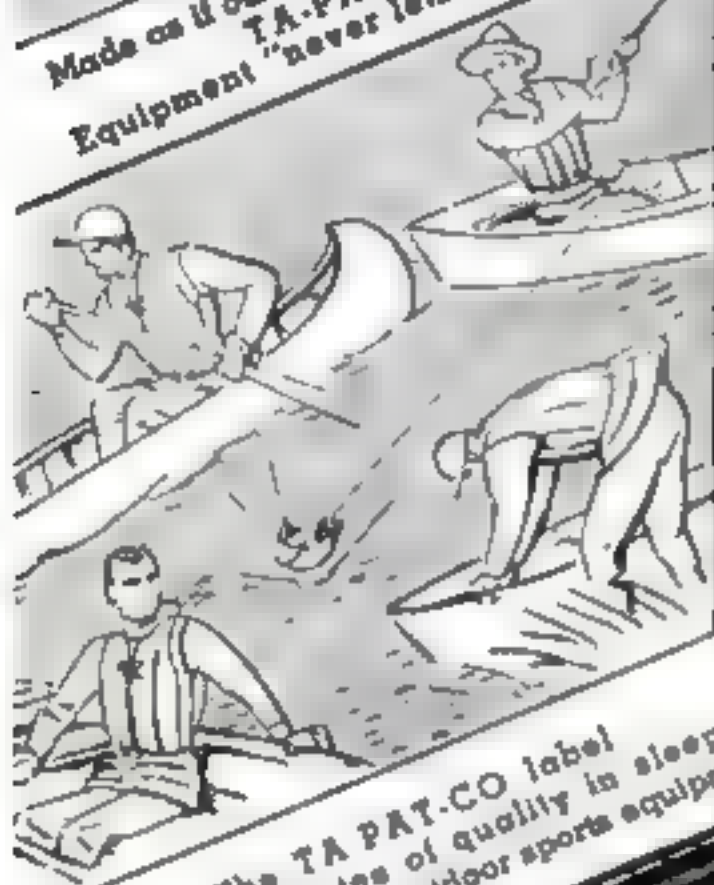
This improved featherweight Ta-pat-co Life Vest will add a new chapter of safety in the history of water sports after the war. It is a Life Vest fisherman, hunters and boatmen will like to wear.

Streamlined, flexible construction gives you *complete* freedom of body movement without binding or discomfort—ample bouyancy without excessive bulk. It's as modern in appearance and as easy to wear as a topcoat—yet always ready to keep you safely afloat should the unexpected happen. And tragic headlines have proved too often that it *can* happen.

Why take a chance that you may so easily and simply avoid? Your life is too precious to hang on the fragile thread of luck.

War needs come first, but after it's over, Ta-pat-co Life Vests will be ready to help you enjoy sports afloat unmarred by the grim specter of tragedy.

Made as if our lives depended on it—
TA-PAT.CO
Equipment "never lets you down!"



The TA PAT.CO label
is your guarantee of quality in sleeping
bags, life-saves and outdoor sports equipment.



Safety

FOR THEM TOO!

Don't let fear for the safety of that boy and girl deprive them of the mighty thrill of going with Dad. Ta-pat-co Stay-A-Float will keep them riding on the water like ducks. It's a big help, too, in teaching youngsters to swim. Put Ta-pat-co Stay-A-Float on your after-war list.



THE AMERICAN PAD & TEXTILE COMPANY
GREENFIELD, OHIO

THE "CC" ZONE
Comfort Conscious
Zone—the space
from floor to stand-
ing height, approx-
imately six feet.

We Have Turned This Room Upside Down

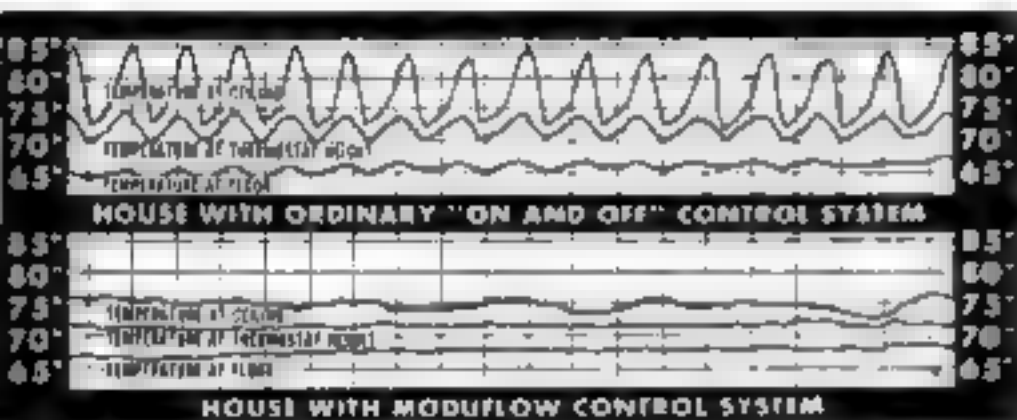
...To Show How MODUFLOW Turns Wasted Heat into Comfort!

Speaking of temperature, our rooms are really "upside down." They are hottest at the ceiling and coldest at the floor.

But Minneapolis-Honeywell engineers have invented a new and different system of heat

control that largely corrects this situation. It is called MODUFLOW. By an ingenious method of heat control and supply, Moduflow more nearly equalizes floor and ceiling temperatures. It uses much of the heat formerly wasted at the ceiling to heat the lower levels. Result—greater efficiency and blissful comfort from top to bottom of your Comfort Conscious Zone.

Learn how easily and inexpensively a Moduflow control system can be installed in your postwar home. Mail the coupon today for free booklet.



See the difference. Shown above are actual temperature recordings taken in two identical test houses—one with and one without Moduflow. Note how Moduflow smooths out the ups and downs of ordinary heating systems—reduces overheating at ceiling and increases floor temperature.

MODUFLOW

THE NEW HONEYWELL HEATING
CONTROL SYSTEM



Free! SEND FOR THIS BOOKLET

Minneapolis-Honeywell Regulator Co.
2912 Fourth Avenue South
Minneapolis 8, Minnesota

Please send my free copy of "Heating and Air Conditioning the Postwar Home"

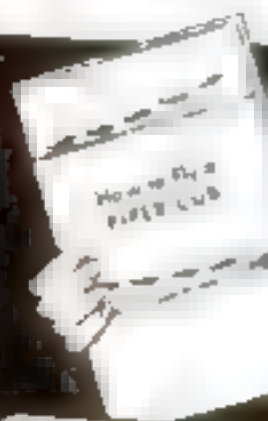
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HAS HELPED
THOUSANDS-IT
WILL HELP YOU!



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A PIPER CUB"
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PIPER CUB

POINTS THE WAY TO WINGS FOR ALL AMERICANS

The Reaction Engine

(Continued from page 220)

fulness. A reaction motor with maximum thermal efficiency will not accomplish anything useful if it is too heavily loaded to be moved by the reaction to the ejection of gas. On the other hand, the mechanical efficiency of a reaction motor free to fly will increase as its speed approaches that of the jet.

In other words, the mechanical efficiency of any jet-driven device depends on its speed. It reaches the maximum only when the craft is moving forward at the same terrific speed that the jet is going backwards.

The ejection velocities of jet-propulsion motors range from about 1,200 feet per second to a theoretical maximum of 17,000 or more feet per second. The lower figure is better than the speed of sound. The upper figure is about six times as high as the speed of an artillery shell. And the speed of a reaction motor is not limited to the speed of its jet; if there is power enough to build up and maintain that velocity, the rocket craft can travel faster than its jet.

Obviously, a rocket motor is no good for slow, leisurely flying. It will never, in the usual sense, be a competitor of any other kind of engine. Far from providing a mere alternative method of transmuting chemical energy into mechanical power, it actually gives us the means of adding an entirely new dimension to the age of flight.

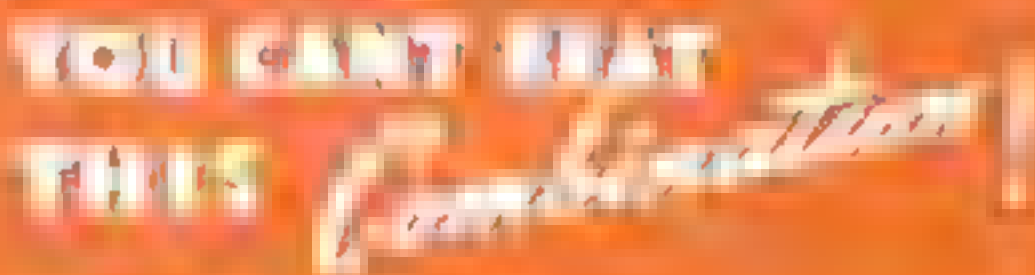
In some of its forms, it operates even better beyond the atmosphere than in the atmosphere. Altitudes hitherto considered unattainable will be reached by utilizing reaction.

In speed, the reaction motor only begins where the gasoline engine and propeller must leave off. For powering aircraft, it must be tamed down. Its jet speed must be reduced and the economy of its fuel consumption improved, because it must operate at speeds reasonable for an airplane—that is, at less than the speed of sound. Air-stream-engine builders, therefore, have sought to increase the power of the jets from their engines, not by raising the velocity of the ejection but by enlarging its volume.

The useful development of reaction power depends on carrying further the work already done. Jet propulsion is here. An age of reaction power is dawning in which we shall become accustomed to great concentrations of power in small space, to ascents to great altitudes, and to speeds almost beyond our imagination.

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MULTIPLE
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Twin and Multiple SPEED NUTS COMBINE Fasteners into One Unit!

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Twin type SPEED NUTS are available with $\frac{1}{2}$ " to 1" hole spacings, for machine or sheet metal screws. Center hole permits riveting in place for blind location assembly.

Multiple type SPEED NUTS are available, with 1" to 2" hole spacings, for 6Z, BZ or 10Z sheet metal screws. Supplied in any desired lengths or in coils. Made of spring steel for riveting in

blind location, or stainless steel for welding.

Where "float" is necessary to compensate for unavoidable misalignment of holes, SPEED NUT Retainer Strips are recommended, as shown in panel at left. Here self-retaining "U" type SPEED NUTS are slipped over aluminum or stainless steel strips, in "floating" register with the screw holes.

In writing for samples, please give screw size and hole spacing.

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Health Insurance FOR YOUR CAR

TO CLEAN OUT
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TO KEEP IT
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Wherever there is internal combustion there are bound to be petroleum residues, known as gum and sludge, which immediately cut down on the power of the engine and eventually destroy it.

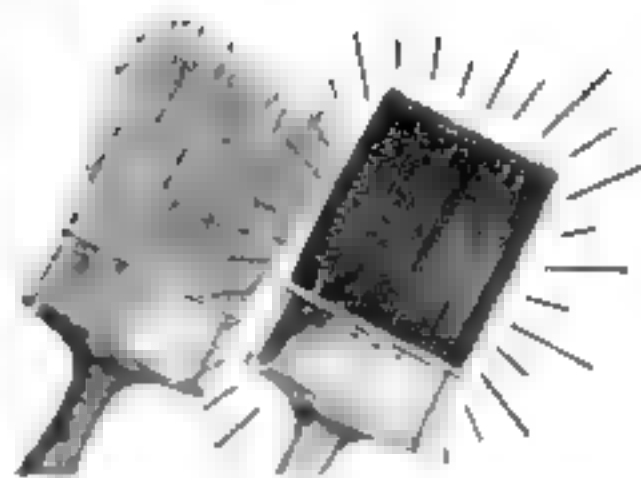
LOOSITE and **SILOO** are solvents of these residues. **LOOSITE** cleans out the engine, then **SILOO** added to fresh crankcase oil keeps it clean. Thus your engine is freed of gum and sludge quickly, safely, economically, while it is in operation. Full power is restored and its life prolonged.

LOOSITE and **SILOO** have been helping car owners to better engine performance for nearly fifteen years. They are equally valuable for tractor or truck, bus or boat as well as all types of diesels. Get the **LOOSITE-SILOO** habit. Your service station can supply you.

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Give them a **Dic-A-Do** Paint Brush Bath.

Removes old paint quickly... Restores spring to the bristles. "War Emergency" brushes require particular cleaning. Be safe with

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FROM "Somewhere in the Pacific"
comes this dramatic letter from
Sgt. John V. W.

"Have been in the Army for two years.
Cannot tell you much, but I have put
in a good many hours on the Harley-
Davidson 45 and have been through
mud and all kinds of weather. It rains
most of the time over here, but nothing
can stop those Harley-Davidsons—not
even bullets. I know for I have been
shot off of them! My name for my
Harley-Davidson is "Commando" and
that's just what it is."

Thanks to you, Sgt. John V. W., and
to thousands of combat riders like you,
the days will come again when red-
blooded motorcycle fans can take in
race meets, hillclimbs, endurance runs,
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the rest of the gang on a brand new
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UP TO ONE GALLON
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SPEED FINAL VICTORY—BUY WAR BONDS



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Brittle Bullets

(Continued from page 87)

duralumin armor, and an automatic, radio-sonic hit indicator.

Frangible bullets are a combination of lead and plastic material. They are hard enough to behave properly when fired from a modified .30 caliber machine gun, and to penetrate ordinary armor plate. But they are soft enough to crumble into dust, and merely leave a slight smudge, when they strike specially treated duralumin armor. Armor of this kind covers the Kingcobras now being used as target planes at AAF flexible-gunnery schools.

The duralumin skins of these planes are sensitive to every blow from the breakable bullet, however, because of the addition of an electrical nerve system. Ten dozen pickups similar to little microphones are connected to the armor. The vibration of the armor when it is hit is felt and amplified by this electrical network to produce three results instantly: a light flashes on the target plane's instrument panel to notify the pilot that his craft has been hit, another light in the propeller hub flashes to tell the gunnery student that his bullets have reached the bull's-eye, and a mechanical counting device keeps the student's score.

Although the Kingcobra carries more than a ton of the special armor, it can go more than 300 miles an hour at 25,000 feet. Effective range of the frangible bullets is 600 yards. Gunnery students, therefore, can now make certain of their ability to shoot down attacking aircraft before they have to do so in real combat.

A good-natured Texas architect, Maj. Cameron D. Fairchild, brought all this about. Three years ago, he saw the need for training gunners as realistically as pilots and navigators were being trained, and appealed to the engineering faculties of 120 leading colleges and universities for help.

Four fifths of the scientists whom he consulted were inclined to pooh-pooh the possibility of making a bullet with good ballistic properties hit an airplane with "a mother's loving touch." It seemed as silly as asking Joe Louis to deliver knockout blows that would not even bruise a baby. Dr. A. D. Moore of the University of Michigan suggested, however, that glass bullets be tried. Corning Glass Works experiments proved that this was a feasible idea, but manufacturing difficulties were encountered.

Duke University, meanwhile, sent its director of research, Dr. Paul Gross, to see Major Fairchild. Together they interested the Office for Scientific Research and De-

(Continued on page 234)

POPULAR SCIENCE

FREE — a liberal education

in doing your own odd jobs

'round the house —



— says Peter Putter

Here's a quick, condensed course in How To Do Your Own Household Repairs—Have Fun—and Save Money! No matter what the fix-up job, there's a Schalk do-it-yourself item that does it; and a Peter Putter 'tested recipe' that shows you how. So why not surprise your friends (and yourself) by proving you're an expert? Ask your paint, hardware or lumber dealer for DOUBLE X (makes varnish vanish, makes old floors new); SAVABRUSH (restores old paint brushes); SCHALK'S CRACK FILLER (fills cracks, holes, nicks in wood, wallboard,

plaster); WAXOFF (removes wax before revarnishing or rewaxing), SCHALK'S WOOD PUTTY (easy to work, contains real wood). Then, for ABC advice on how to do it, mail the coupon!

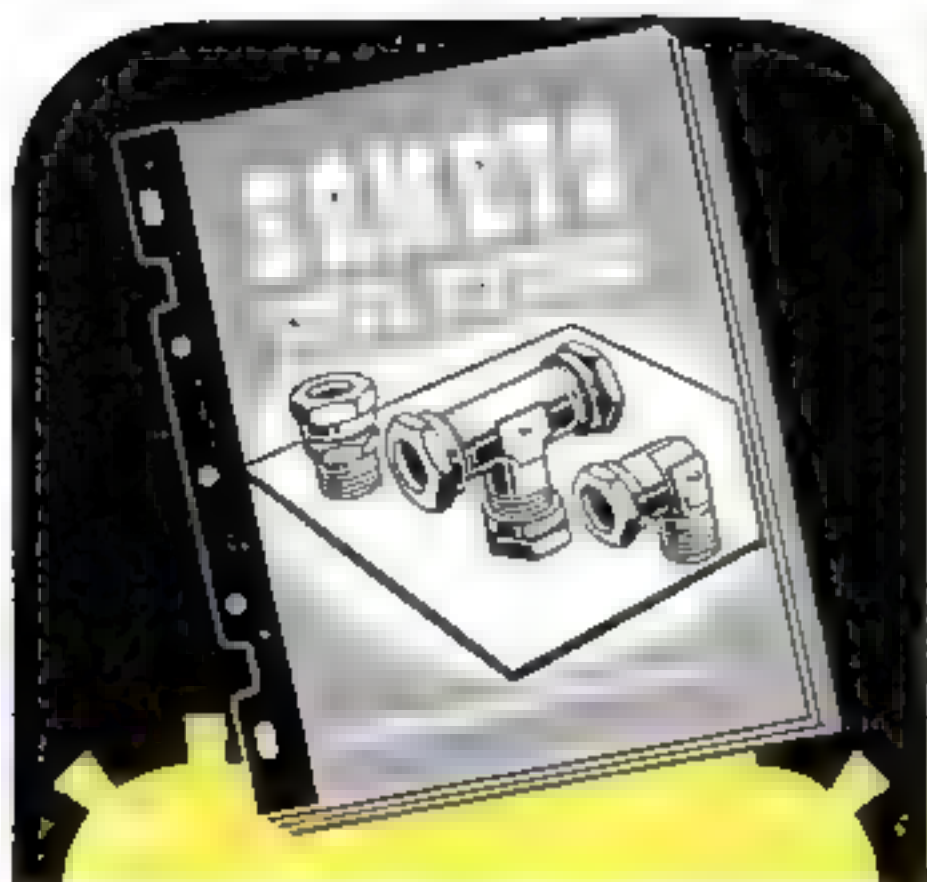
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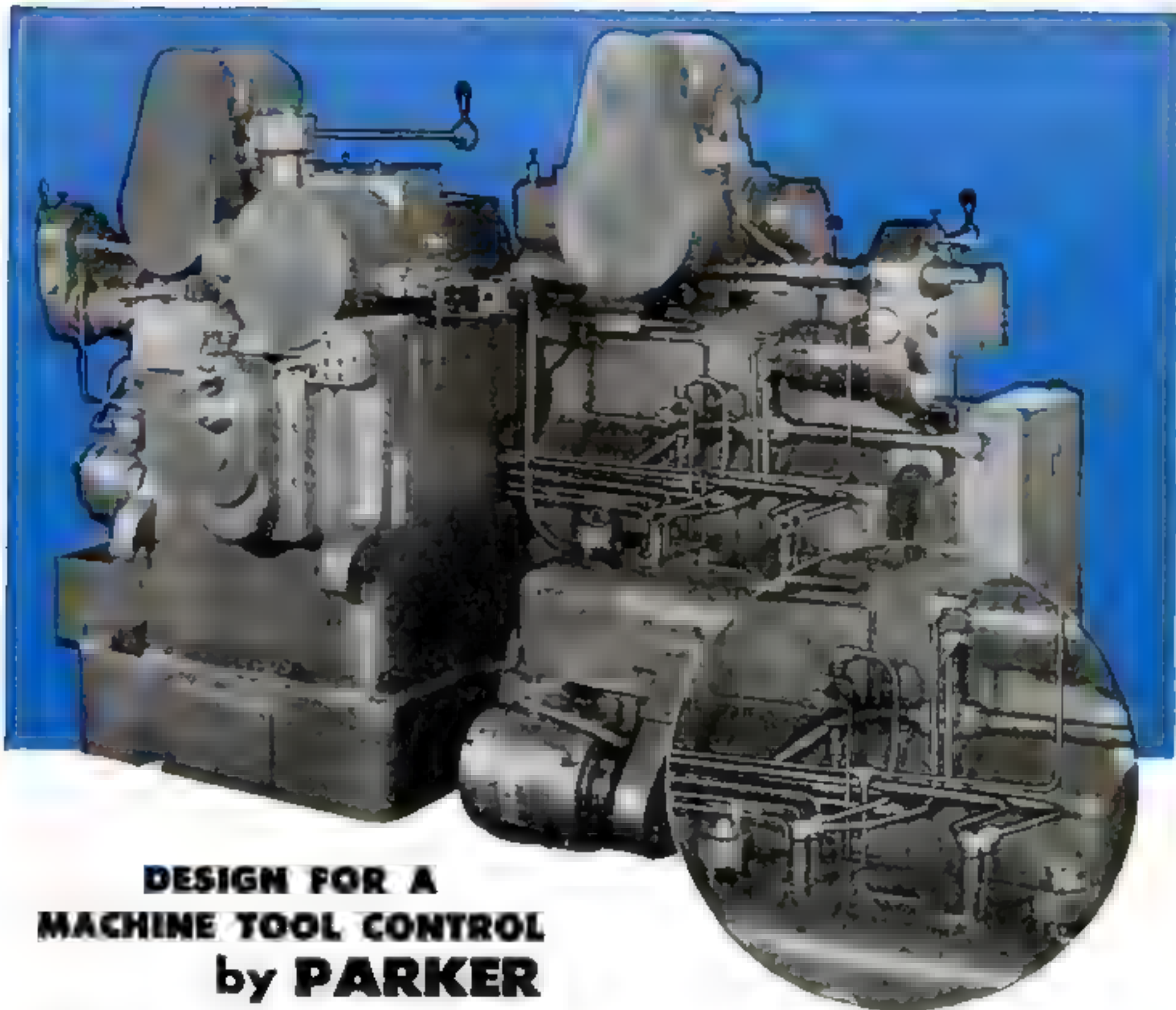
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Here is an unusually flexible machine that can be used for routing, shaping and carving wood, metal or plastics. Combines high speed (20,000 R.P.M.) power (1200 watts at the spindle) and solid, heavy construction that gives smooth, vibrationless cutting. Is extremely flexible—can be transformed quickly into a Shaper or Carver. Standard equipment handles 1/4", 5/16 and 3/8" bits for routing—5/16" and 1 1/2" bore shaper cutters—and all standard cutters for carving. Has many special features including: Specially designed G. E. Universal Motors, New Departure Precision ball bearings, precision machining throughout; Table can be instantly adjusted to any height without holding foot pedal. Chuck is part of spindle and holds adaptor and cutter close to work, thus preventing whip. Many other exclusive features. Unusually low priced.

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"Don't fret, Mrs. Wattlbottom—Henry will have that fixed in a minute with a little Weldwood Glue!"

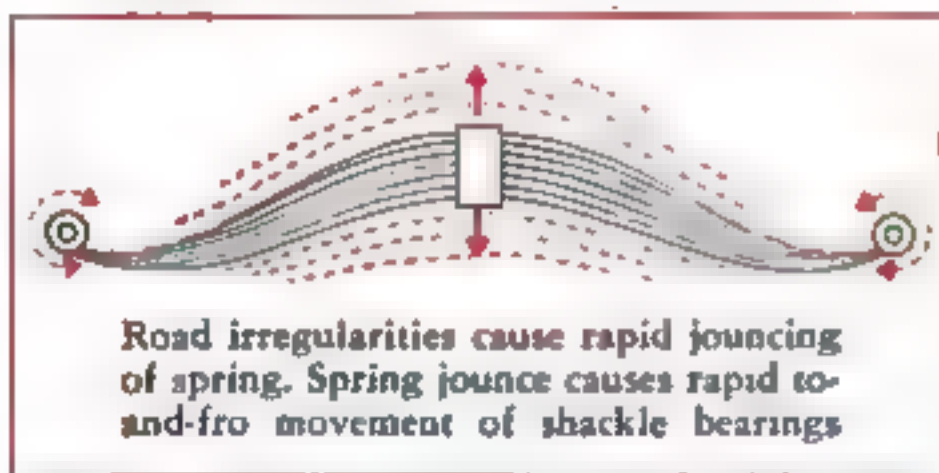
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The frictional heat so developed is sufficient to "melt" a poor lubricant right out of a bearing, and oxidation causes it to gum and dry out so that the lubricant no longer offers protection to bearing surfaces. Your car no longer rides smoothly. *You can feel the difference!*

Marfak chassis lubricant is scientifically designed to overcome these driving conditions. You can *feel* its cushioning effect as you drive. The combination of its ingredients gives Marfak both cohesive and adhesive qualities so that it clings to bearing surfaces and resists any tendency to wash out, jar out or squeeze out. These hand tests demonstrate why Marfak sticks to the job:



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John Hudson Moore, Inc., 863 Fifth Ave., N. Y. 22
Distributors also of Sportsman Pipe Mixture, Sassenl
Fine English Pipes and Sportsman Toiletries for Men.

Brittle Bullets

(Continued from page 228)

velopment. Col. Jake Smart brought the AAF School of Applied Tactics into the picture. Princeton University, the Bakelite Research Laboratories, Sperry Gyroscope Company engineers, and other civilian and military agencies helped explore the problem's many aspects.

Eventually, Dr. Gross and his assistant, Dr. Marcus Hobbs, produced a projectile combining tiny globules of lead with thermosetting resin. Courageous showmanship was still necessary, however, to sell the idea of letting machine guns fire these bullets directly at human beings for practice.

Brig. Gen. Kenneth P. McNaughton picked up one of the bullets during a conference with AAF headquarters officers and, before anyone could stop him, hurled it down on the plate-glass top of his desk. Even Major Fairchild winced. But the bullet shattered without breaking the glass.

The first airplane to be turned into a target and flown by Captain Everett, was an A-20 called the "Aiclad Nag." The Bell P-63 Kingcobra was selected later as the best type because its completely enclosed liquid-cooled engine and clean lines made it easier to cover with armor.

When altered for use as target craft, the Kingcobras are called RP-63's, the "R" indicating that they are restricted from combat. The propellers are especially thick-skinned. Grilles protect the air intakes and exhaust outlets, and the pilots' seats are surrounded by armor plate and inch-thick, bullet-resisting glass.

The first two of these planes, painted a bright orange, began making passes at bombers last fall near Laredo, Texas. Guards on horseback patrolled the Rio Grande Valley ranchland while thousands of rounds of breakable bullets were fired at the planes. The results were so good that AAF headquarters authorized the use of 300 P-63's as targets, and a special assembly line in the Bell plant at Niagara Falls was set up to produce them.

"Training bombardment gunners the way we had to do it in the past," one officer has explained, "was like training a prize fighter for a championship bout without sparring partners, and with shadowboxing only." The frangible bullets, he believes, has made this comparison at least 50 percent invalid.

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Dependable patented magazine feeder. Automatic slide ejection. 25 shots for vermin and small game.

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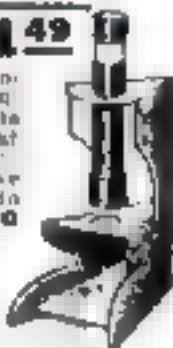
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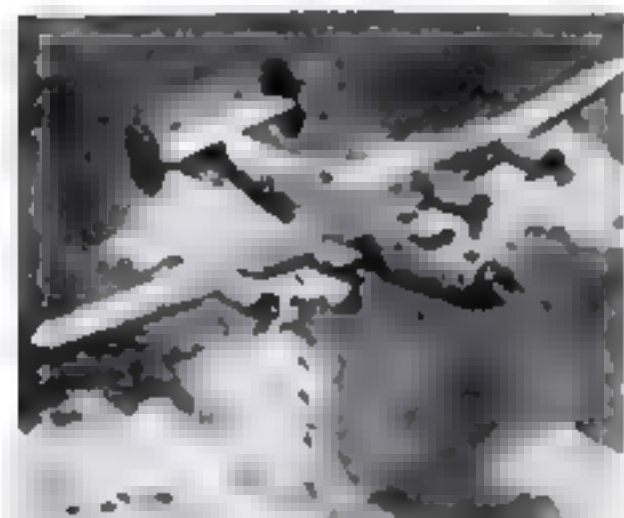


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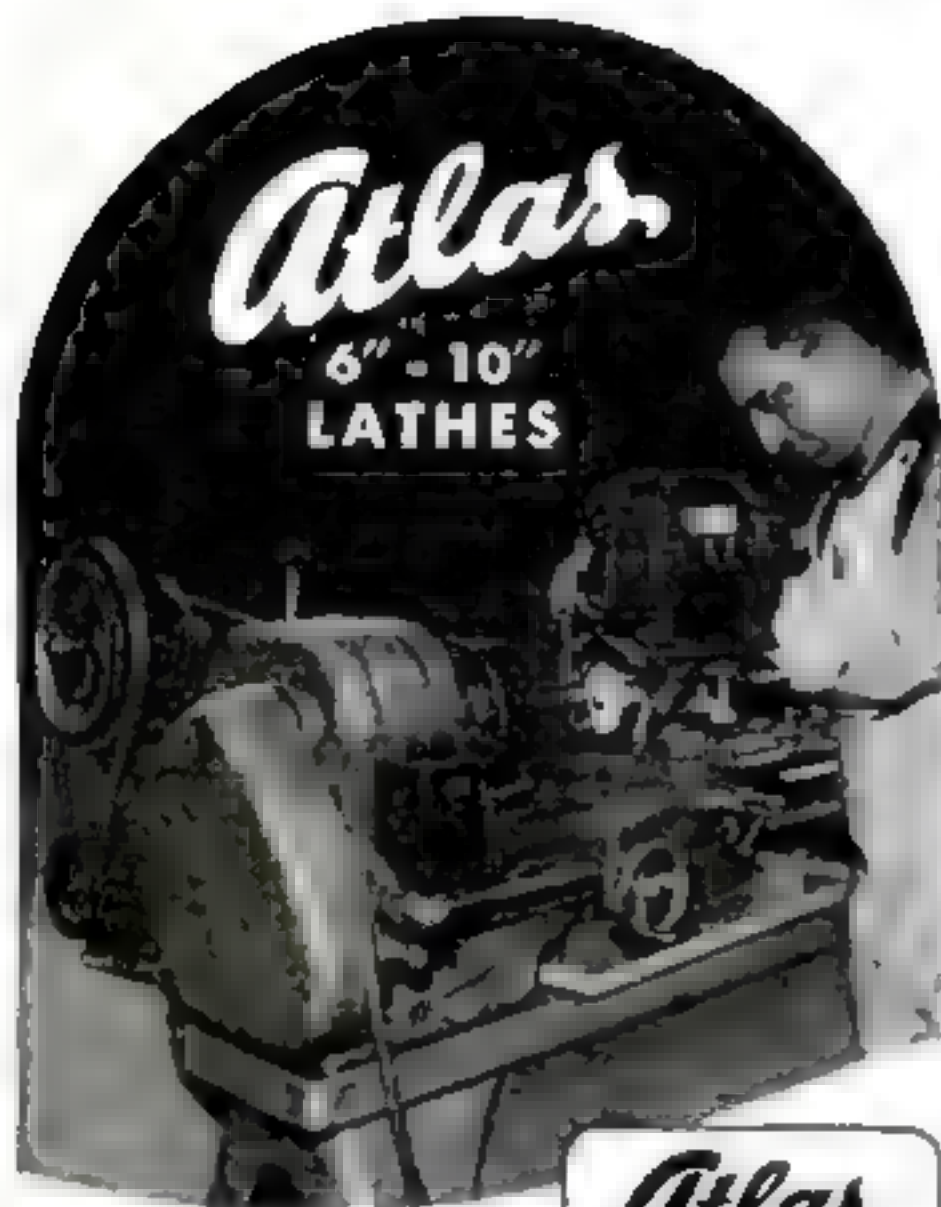
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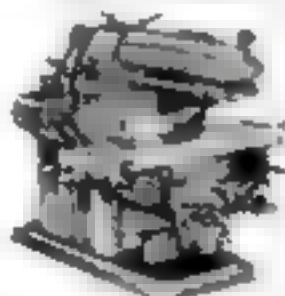


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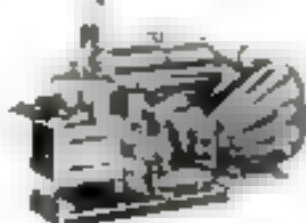
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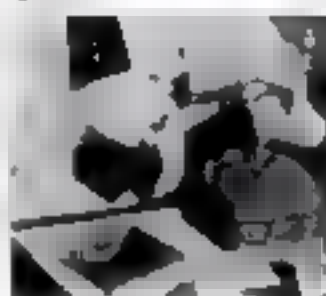
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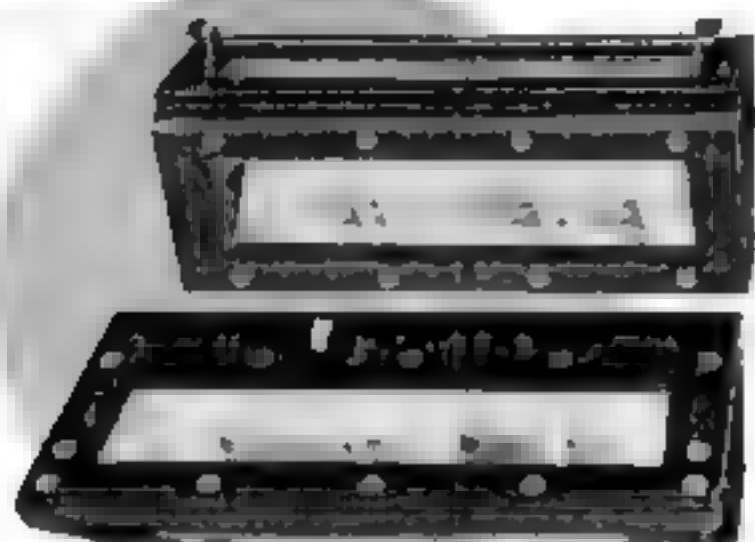
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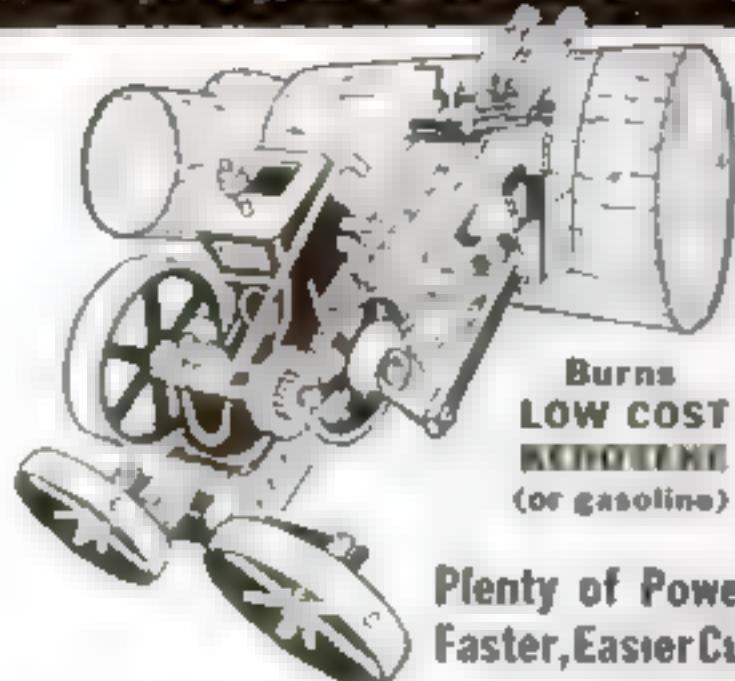
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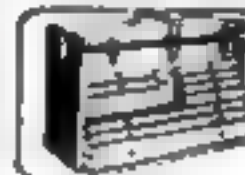


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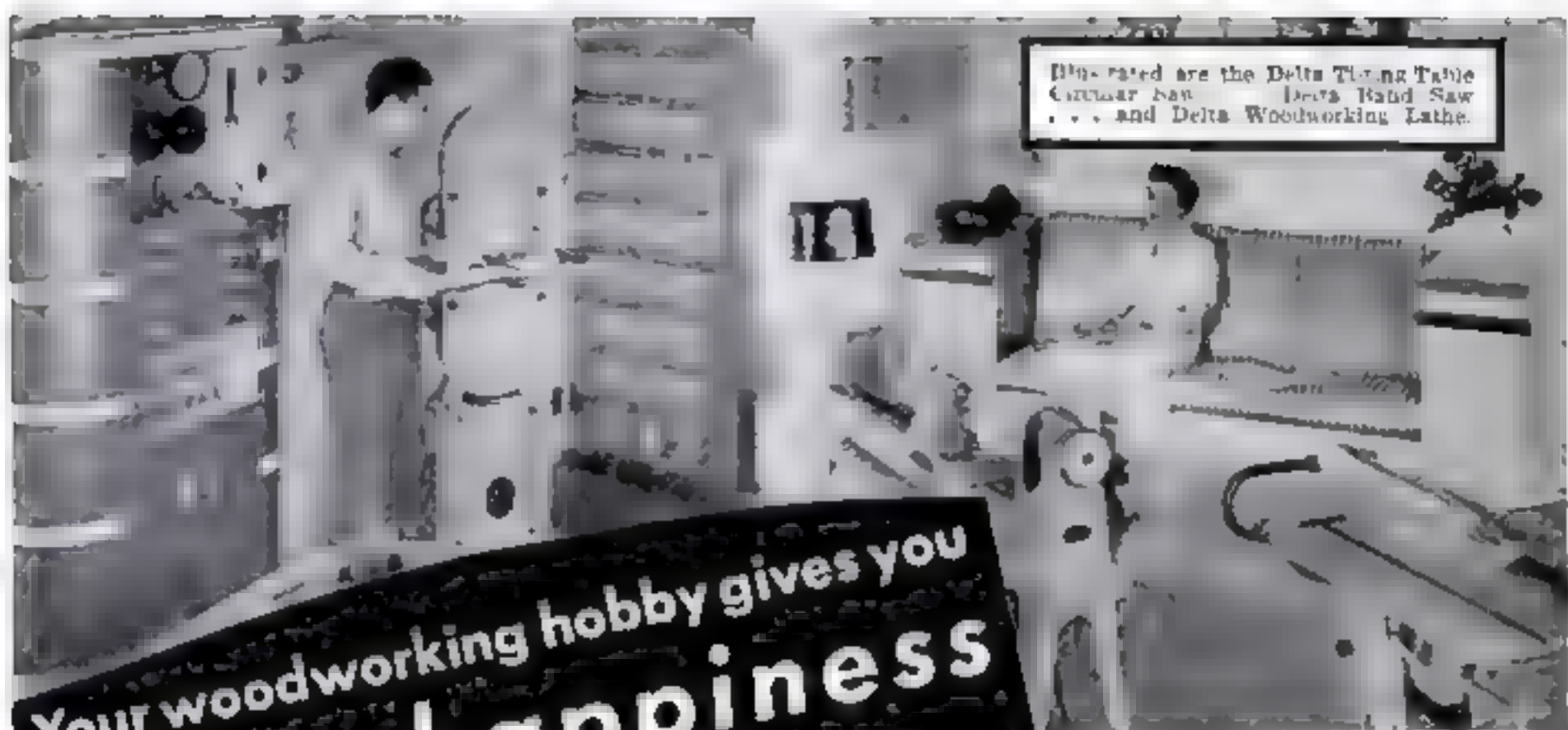
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Illustrated are the Delta Tilting Table Circular Saw, Delta Band Saw, and Delta Woodworking Lathe.

Your woodworking hobby gives you
more happiness

...when you enjoy the deep satisfaction
of using **quality** power tools —

Delta Homecraft* Power Tools

Here are tools you can count on to
give you dependable performance

Any woodworking enthusiast can tell you that using your hands to make good-looking things pays off in pride and pleasure and mental alertness. It's a happy hobby!

But whether you enjoy all of the fun woodworking can give you — or miss out on part of it — depends to a considerable degree on whether or not you enjoy the service of **quality** tools.

Yes, your tools — both hand tools and power tools — can make a difference.

It's because **quality** is so important that Delta Homecraft Power Tools are used by woodworkers everywhere. Delta's "hidden values" in construction — quality engineering features that mean a lot to your contentment — help you obtain accuracy, economy, dependability, safety.

Take Delta's double-sealed ball bearings, for instance. These are bearings that are fully protected against harmful dust, assuring you of longer bearing life. You don't have to bother about oiling them, because they stay lubricated for life, when they leave the factory.

The bearings are also **pre-loaded**. This is an extra manufacturing operation that eliminates the "play" in the bearings, to help you enjoy long-time operating efficiency and accuracy.

These bearings fit snugly into **precision-bored bearing seats**. This helps to keep the bearings lined up properly, so that you have greater assurance of finishing pieces to exact dimensions.

Precision-ground shafts are another example of Delta's quality workmanship. These are shafts which run without any "wobbling" which might throw off your measurements.

To help eliminate annoying, damaging vibration, the pulleys which transmit the power from your motor to your power tool are **dynamically balanced**.

If you're a woodworking hobbyist — anxiously awaiting the day you can become one — plan now on enjoying these quality features that help you get the most out of your absorbing hobby. Plan on getting Delta Homecraft Power Tools, when they are again available.

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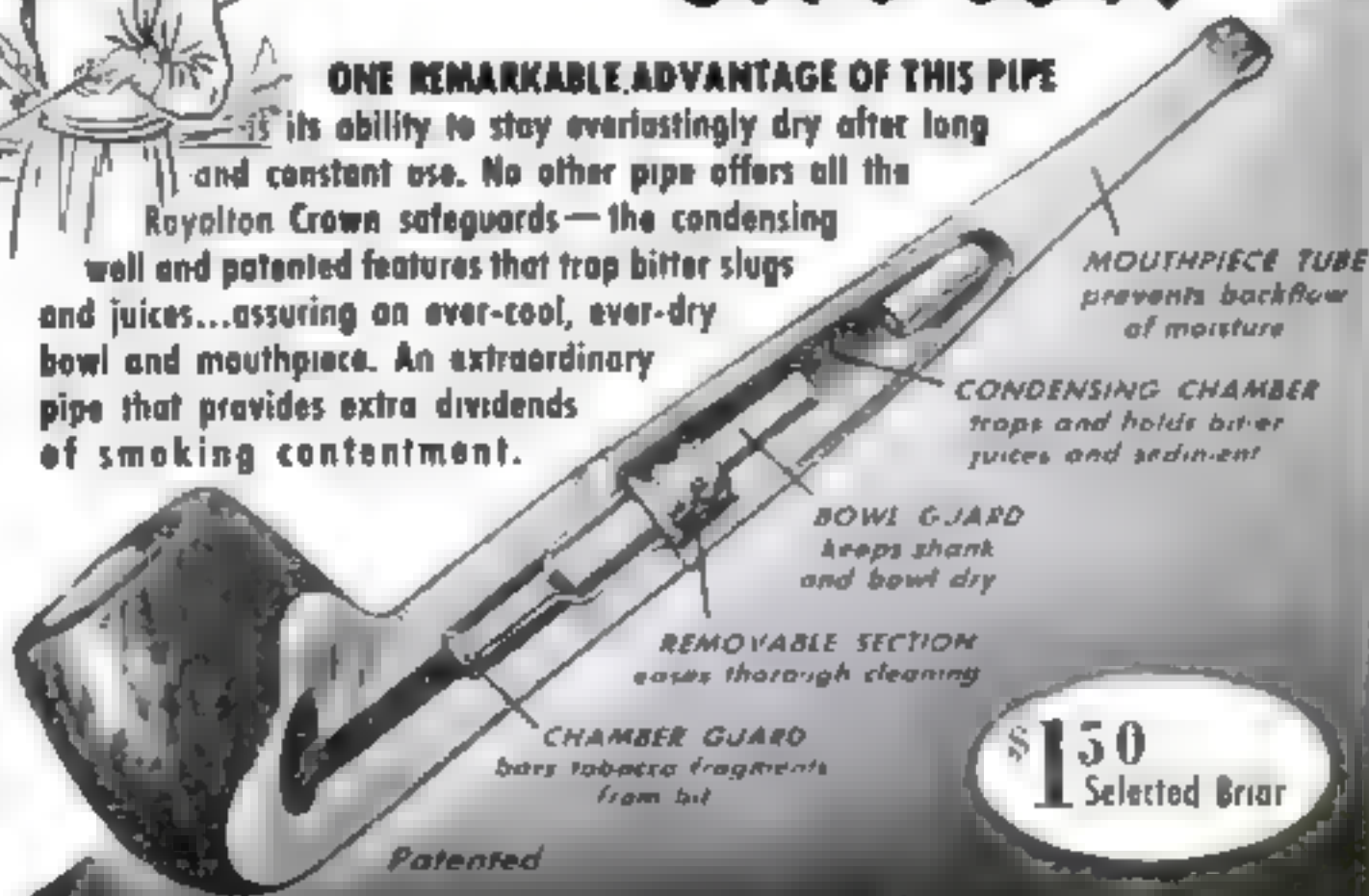
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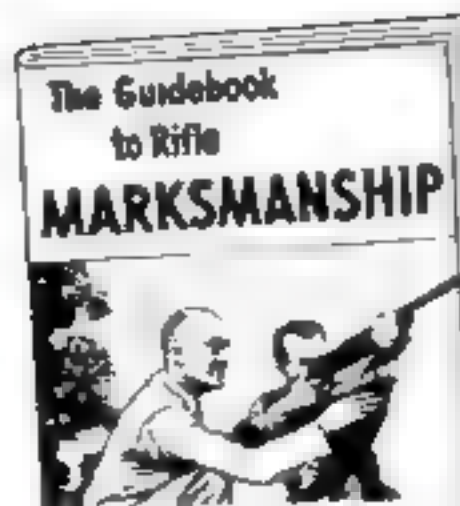
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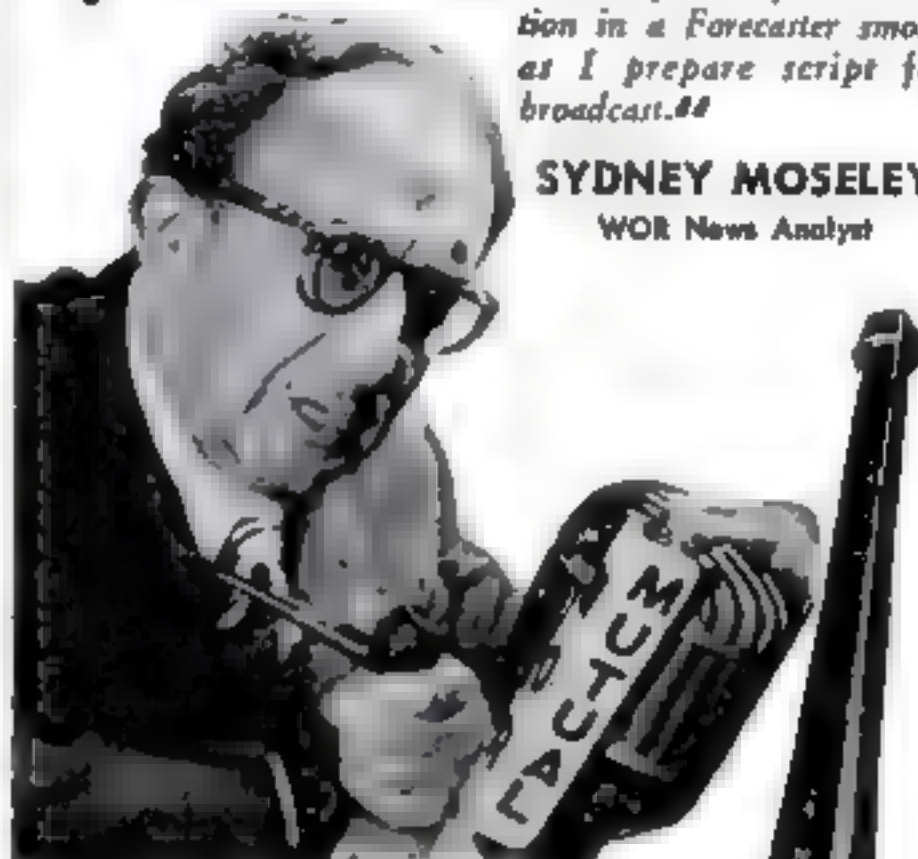
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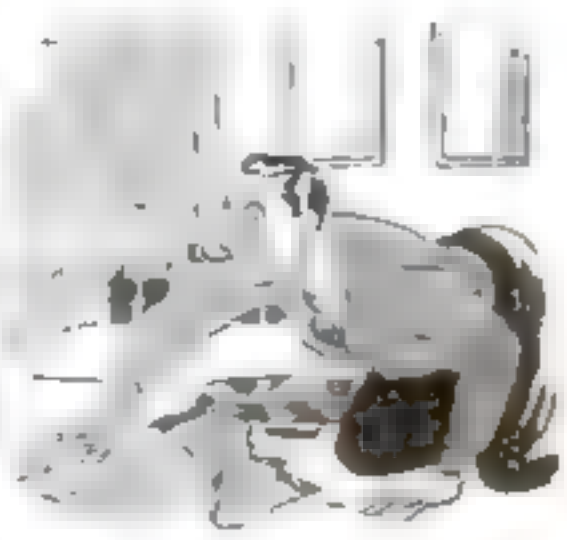


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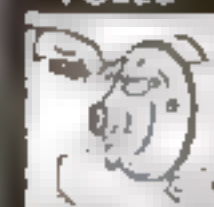
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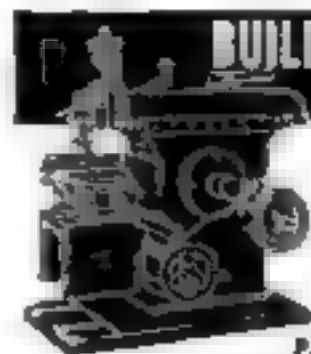


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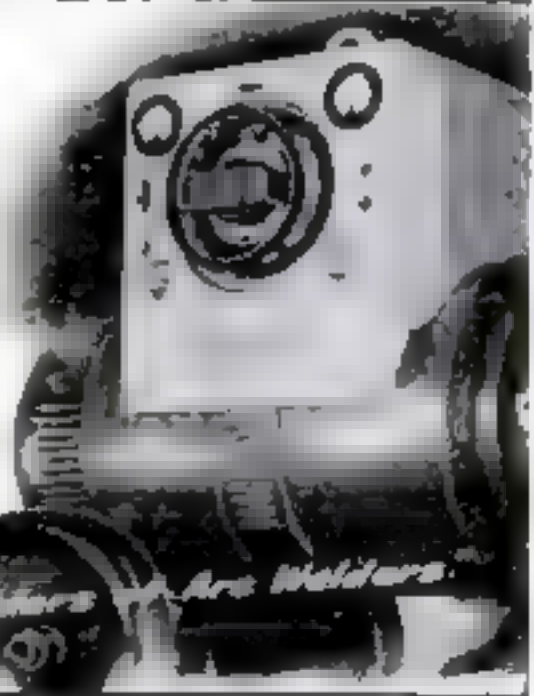
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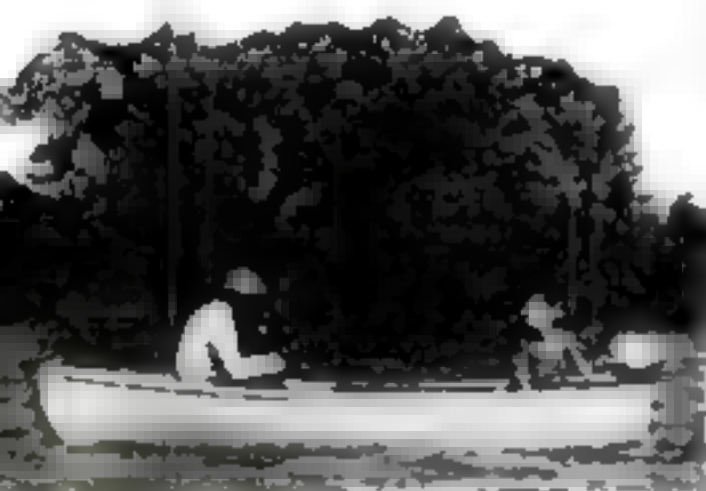
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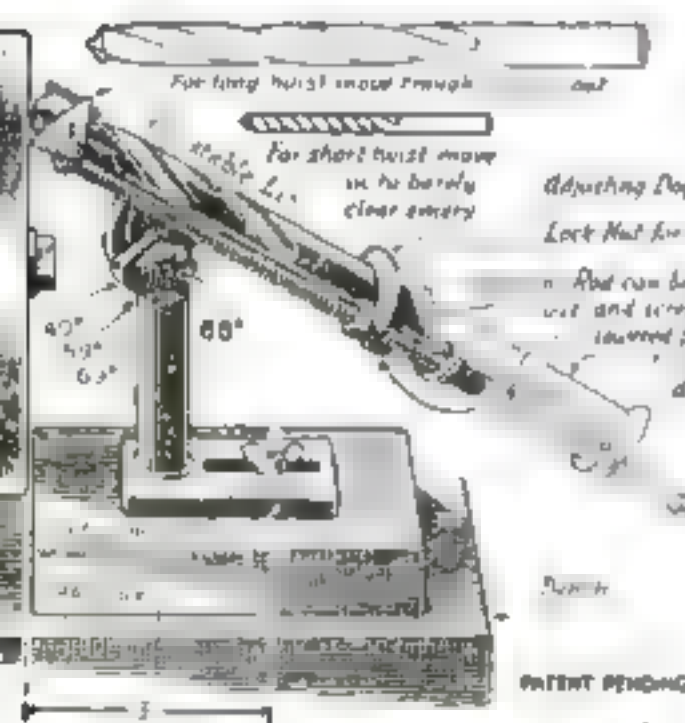
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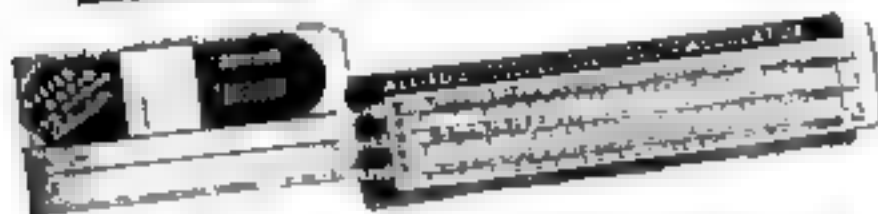
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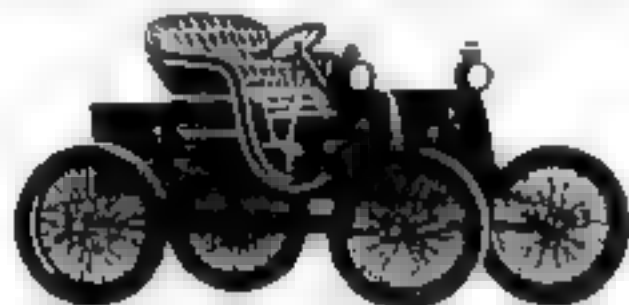
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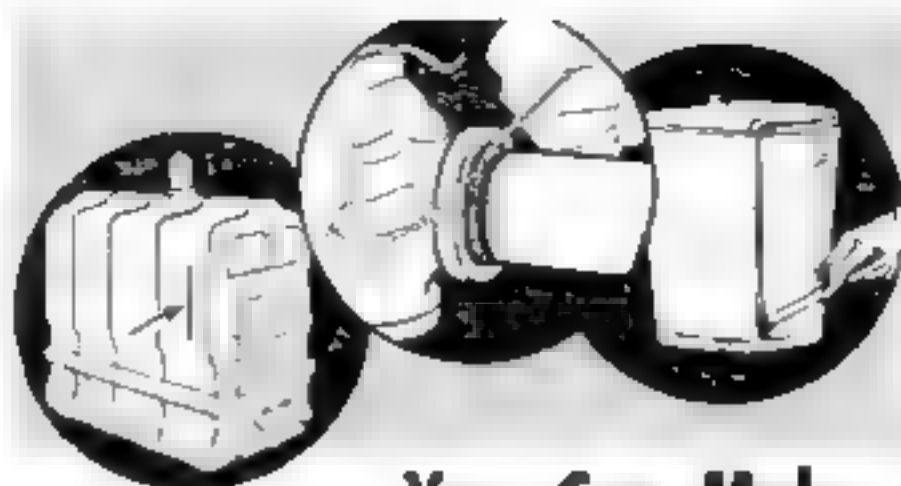
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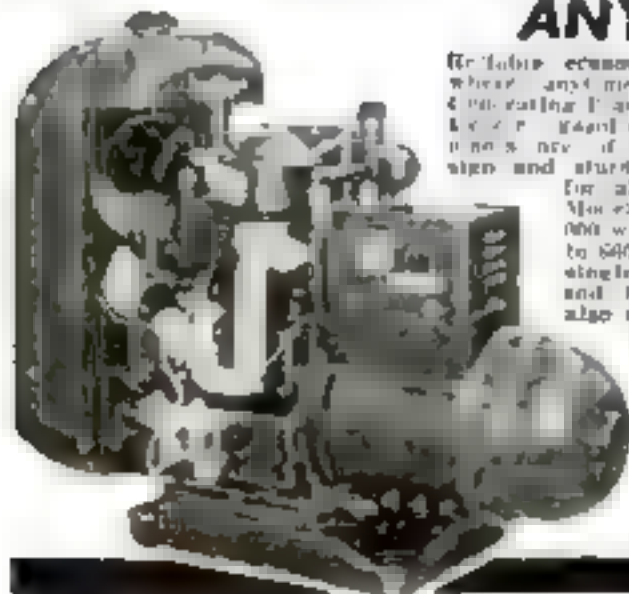
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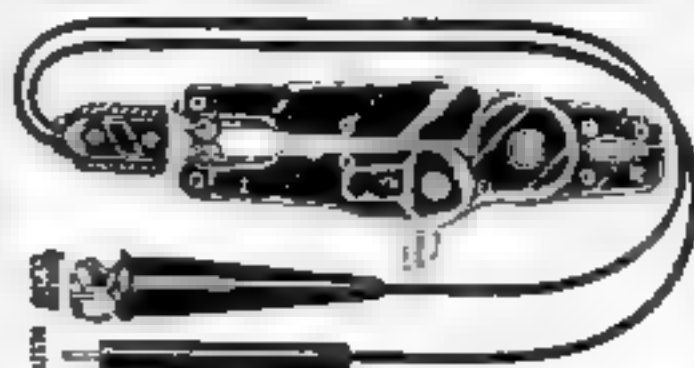
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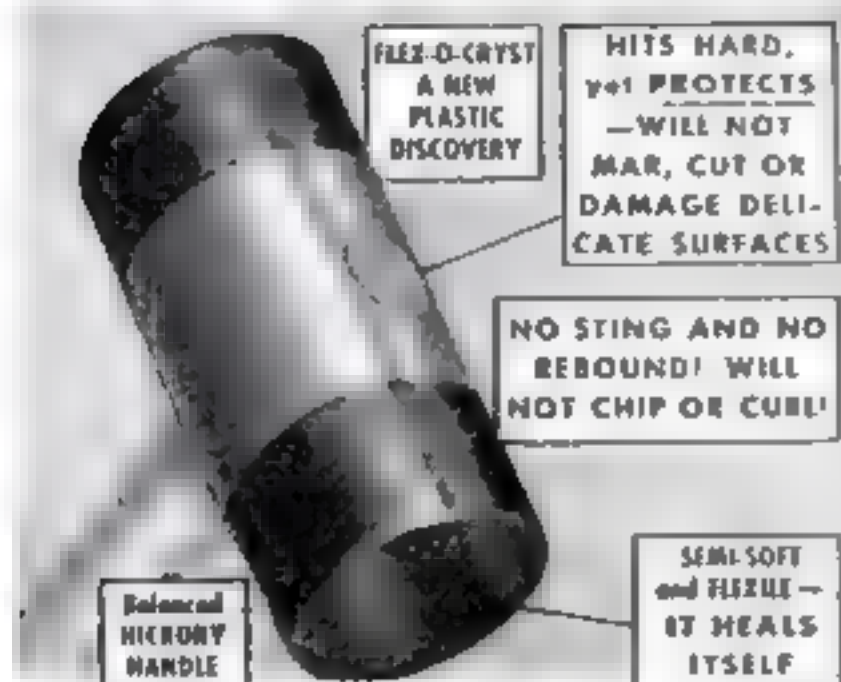
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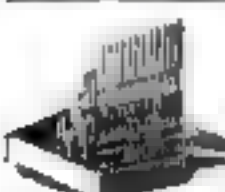
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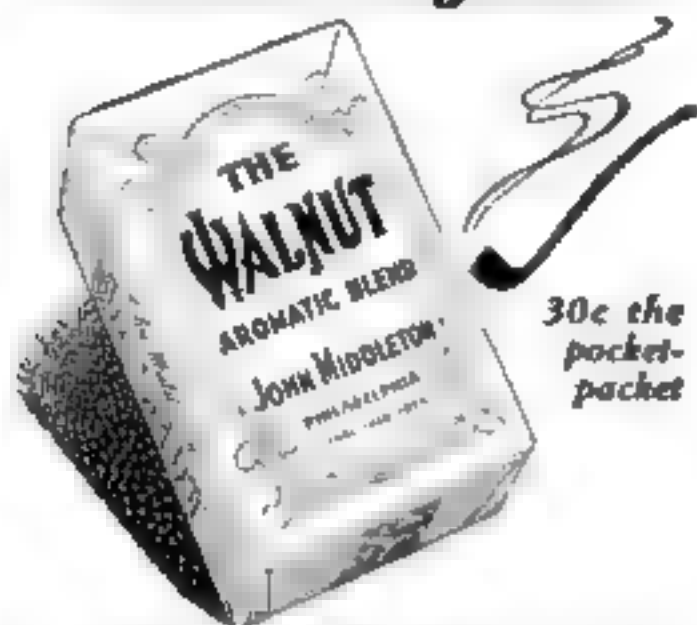
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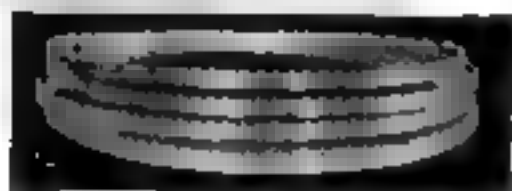
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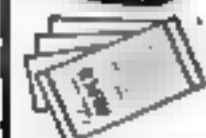
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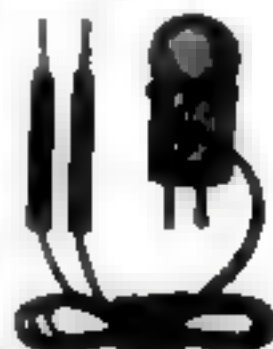
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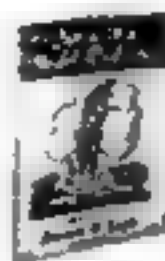
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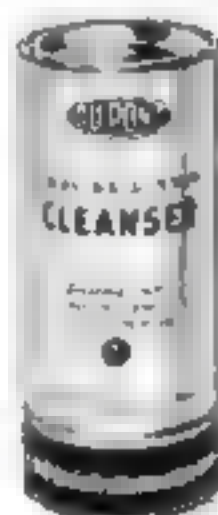
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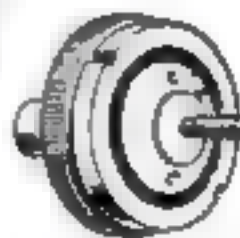
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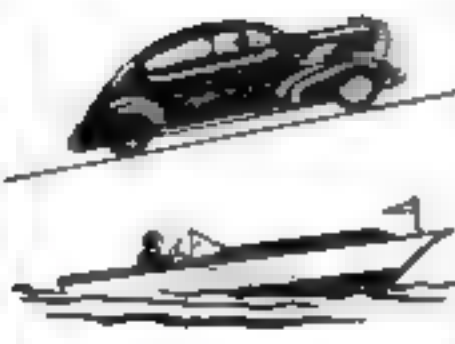
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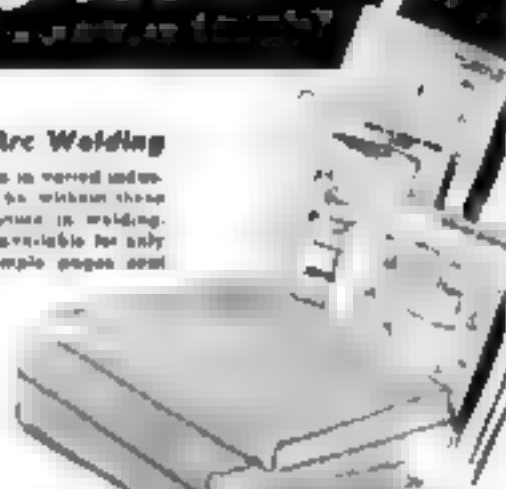
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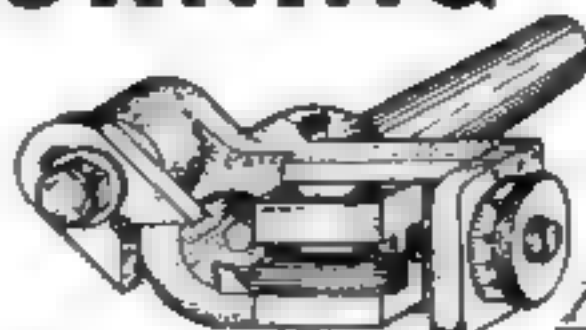
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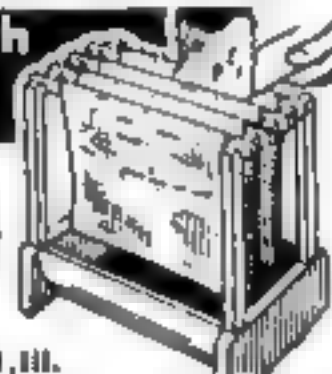
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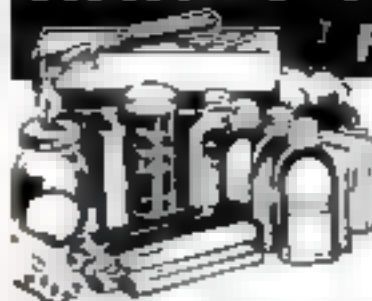
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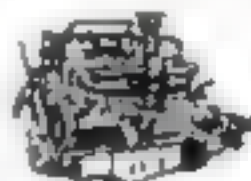
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➔ You can't change gas rationing, but you can make sure that each precious gallon of gasoline is providing you with the maximum mileage of which your car is capable. Now you can get added mileage . . . plus quicker starting and more power! Make this trial test. Install a Vacu-Matic on your car and get up to 30% extra mileage on a money-back guarantee.

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• Vacu-Matic is constructed of six parts assembled and fused into one unit, adjusted and sealed at the factory. Nothing to regulate. Any motorist can install in ten minutes. The trial offer coupon will bring all the facts. Mail it today!

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• Vacu-Matic is entirely different! It operates on the supercharge principle by automatically adding a charge of extra oxygen drawn free from the outer air, into the heart of the gas mixture. It is entirely automatic and allows the motor to "breathe" at the correct time, opening and closing automatically.

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• In addition to establishing new mileage records on cars in all sections of the country, the Vacu-Matic has proven itself on thousands of road tests and on dynamometer tests which duplicate road conditions and record accurate mileage and horsepower increases. Thousands of motorists now enjoy extra mileage—improved performance with Vacu-Matic.

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Send this Coupon Today

THE VACU-MATIC COMPANY
7617-1209 W. State St., Wauwatosa 13, Wis.

Please send full particulars about VACU-MATIC, also how I may obtain one for trial on my car. This does not obligate me in any way.

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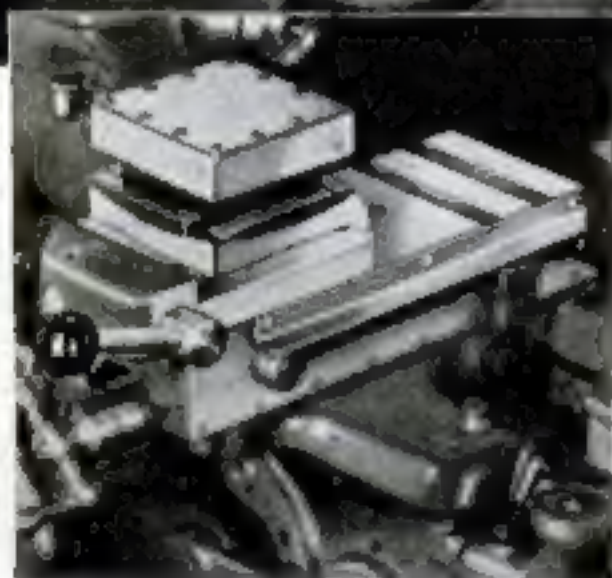
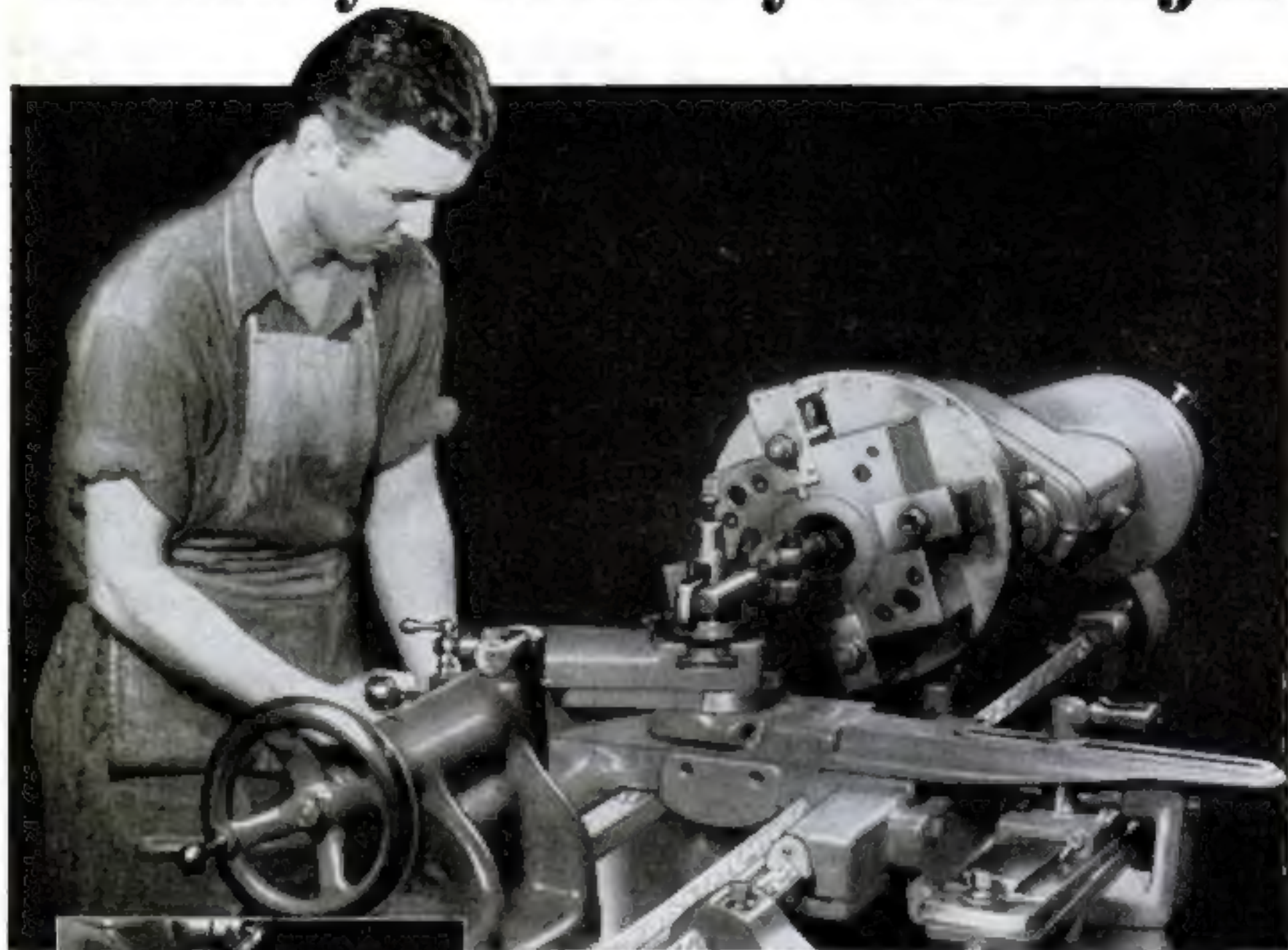
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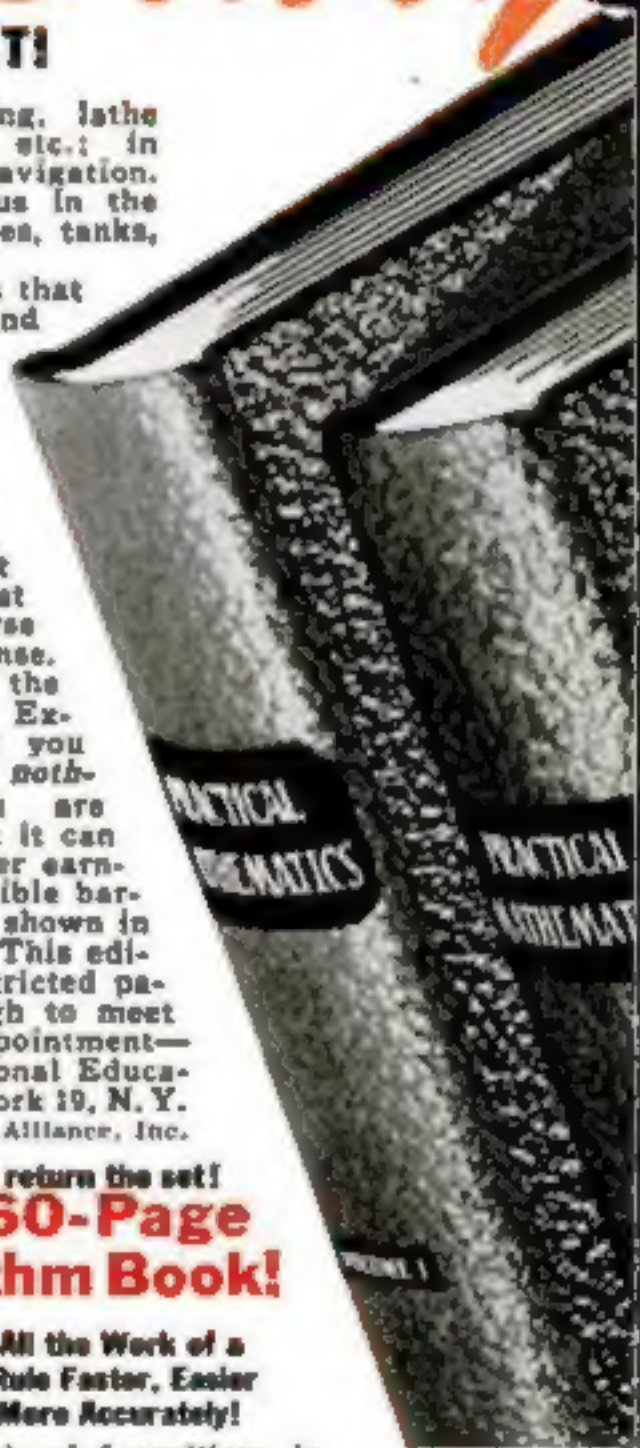
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Mallory Tropical Dry Batteries have gone a long way toward solving the problems. Originally developed by Mallory for the Army Signal Corps, these batteries are fundamentally different, giving incredibly longer life in smaller, lighter units. High temperatures have little effect on life and performance. Hermetically

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Not only for field communication work, but for mine detection and other military requirements, Mallory Tropical Dry Batteries have stepped up dependable battery performance enormously.

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